Study on Invasive Alien Species – Development of risk assessments to tackle priority species and enhance prevention

Contract No 07.0202/2016/740982/ETU/ENV.D2

Final Report

Annex 1: Risk Assessment for *Acridotheres tristis* (Linnaeus 1766)

Risk assessment template developed under the "Study on Invasive Alien Species – Development of risk assessments to tackle priority species and enhance prevention" Contract No 07.0202/2016/740982/ETU/ENV.D2 **Based on the Risk Assessment Scheme developed by the GB Non-Native Species Secretariat (GB Non-Native Risk Assessment - GBNNRA)**

Name of organism: *Acridotheres tristis* (Linnaeus 1766)

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Risk Assessment Area: The geographical coverage of the risk assessment is represented by the territory of the Union (excluding the outermost regions).

Peer review 1: Rob Tanner, European and Mediterranean Plant Protection Organization (EPPO/OEPP), Paris, France
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This risk assessment has been peer-reviewed by two independent experts and discussed during a joint expert workshop. Details on the review and how comments were addressed are available in the final report of the study.

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RISK SUMMARIES			
	RESPONSE	**CONFIDENCE**	**COMMENT**
Summarise Entry	very likely	high	The most important active pathways for introduction of *A. tristis* are the pet trade and the zoological facilities, along with the human assisted transport as a hitchhiker on ship/boat. The most important active pathways for entry into the wild are intentional releases and unintentional escapes from such keepings, along with the natural dispersal. Although the number of specimens involved are not well known, the species is already in the EU, which is why the overall score is "very likely".
Summarise Establishment	likely	high	The species is already locally established in the Mediterranean region, but in the current climate has the potential to establish also in the Steppic, Black Sea, and (at least in part) Alpine biogeographical regions. Climate change is predicted to increase suitability in all of these regions, as well as extending the suitable region into all biogeographical regions of the EU, with the only exception of the Arctic region.
Summarise Spread	moderately	medium	There is no evidence for a rapid natural spread of this species in Europe. However, a continuous spread from the Iberian Peninsula to the North and East is likely without countermeasures and likely promoted in foreseeable climate change conditions. The dispersal rate of the species is usually low, although there is evidence (outside the EU) of dispersal over large distances.
Summarise Impact	major	medium	The species has a major impact on biodiversity elsewhere in the world, specifically on other bird species, including rare and protected species. The transferability of such evidence to the risk assessment area (EU) is hindered by incomplete data; however, the significant impacts reported in different regions of the world lead to expect similar effects also in the European region. The species is likely to thrive best in (sub)urban habitats, some of which may have high and increasing conservation value. In addition, the species has manifold, but usually minor economic and human health impacts.
Conclusion of the risk assessment	high	medium	This species is likely to establish and spread in the Mediterranean region and possibly other regions in the EU if no action is taken. In its introduced range, it has a major impact on biodiversity and related ecosystem services, including additional impacts on the economy and human health, and provides no benefits. Although confidence in the conclusion is limited due to transferability of data, available evidence suggest that this species poses a serious risk to biodiversity in the EU. Although the evidence is weak and largely by extrapolation from other countries, the precautionary principle should apply.

Distribution Summary (for explanations see EU chapeau and Annex IV):

Member States

	Recorded	Established (currently)	Established (future)	Invasive (currently)
Austria	YES	-	YES	-
Belgium	YES	-	YES	-
Bulgaria	-	-	YES	-
Croatia	-	-	YES	-
Cyprus	-	-	YES	-
Czech Republic	-	-	-	-
Denmark	-	-	YES	-
Estonia	-	-	YES	-
Finland	YES	-	-	-
France	YES	-	YES	-
Germany	YES	-	YES	-
Greece	-	-	YES	-
Hungary	-	-	YES	-
Ireland	-	-	YES	-
Italy	YES	YES	YES	-
Latvia	-	-	YES	-
Lithuania	-	-	YES	-
Luxembourg	-	-	YES	-
Malta	-	-	YES	-
Netherlands	-	-	YES	-
Poland	YES	-	YES	-
Portugal	YES	YES	YES	YES
Romania	-	-	YES	-
Slovakia	-	-	YES	-
Slovenia	YES	-	YES	-
Spain	YES	-	YES	YES
Sweden	YES	-	YES	-
United Kingdom	-	-	YES	-

EU biogeographical regions

	Recorded	Established (currently)	Established (future)
Alpine	-	-	YES
Atlantic	YES	-	YES
Black Sea	-	-	YES
Boreal	-	-	YES
Continental	YES	-	YES
Mediterranean	YES	YES	YES
Pannonian	-	-	YES
Steppic	-	-	YES

EU CHAPEAU		
QUESTION	**RESPONSE**	**COMMENT**
Ch1. In which EU biogeographical region(s) or marine subregion(s) has the species been recorded and where is it established?	The species has been recorded in the Continental, Atlantic, Macaronesia and Mediterranean biogeographical regions. However, it is currently established in the Mediterranean region only.	Although the species did successfully breed in the Atlantic and, outside the risk assessment area, Macaronesian region, the population did not persist (as it was eradicated).
Ch2. In which EU biogeographical region(s) or marine subregion(s) could the species establish in the future under current climate and under foreseeable climate change?	According to a species distribution model based on occurrence and ecological data from the native and non-native range (see Annex IV), in terms of biogeographical regions, those predicted to be most suitable for *A. tristis* establishment in the current climate are Mediterranean, Steppic, Black Sea, and (at least in part) Alpine. Climate change is predicted to increase suitability in all of these regions, as well as extending the suitable region into all biogeographical regions of the EU, with the only exception of the Arctic region	Common Mynas are originally from tropical and subtropical climates hence severe winters may be the most limiting factor. Therefore, further warming of the climate due to climate change, may benefit the species in colonising new areas, i.e. by the 2070s, climate change is predicted to increase suitability in the 'already-suitable' region of Europe and also expand the suitable region northwards (see Annex IV). Populations once established in Macaronesia were eradicated (Saavedra et al. 2015).
Ch3. In which EU member states has the species been recorded? List them with an indication of the timeline of observations.	The current status of the Common Myna in the EU is not entirely clear, but the presence of the species has been recorded in at least eight EU countries: Spain, Portugal, Italy, France, Belgium, Austria, Poland Germany, Sweden, Finland and Croatia. The first records of reproduction were reported in Rome (Italy) in 1992 (Restivo and Giacobbe 2010) and in Mallorca (Balearic islands, Spain) in 2001 (Saavedra et al. 2015). Earliest casual observations date back to 1906 in Germany (Rabitsch et al. 2015).	The species has been recorded in both Portugal and Spain, including in the Balearic island (Saavedra et al. 2015). In Portugal there is sufficient evidence to suggest that the Common Myna is breeding in the Lisbon area (Saavedra et al. 2015), but in Spain reproduction was never confirmed. A notable exception is the breeding population in the Balearics, Mallorca, reported since 2001. However the species is now absent from the Spanish archipelago following eradication accomplished in 2007 (Saavedra et al. 2015). As a side note, there are also records of occurrence of the species in some EU outermost regions, namely in the Canary archipelagos, Spain, and Madeira, Portugal (Saavedra et al. 2015). In particular, it is worth mentioning that the reproduction was once confirmed in the Canaries, where the species is now absent following eradication. As summarized by

		Saavedra et al. (2015) the first confirmed reproduction was reported in 1993 in the Canary archipelago, Tenerife, followed by reports in Gran Canaria in 2002, and Fuerteventura in 2006. There are currently no populations in Tenerife, Gran Canaria and Fuerteventura following the control campaigns carried out between 1999 and 2008 (Saavedra et al. 2015). The species has been recorded several times in Italy, at least since 1987 (see Andreotti et al. 2001). Since then, records of occurrence of the Common Myna, as well as breeding events, have been frequent in many regions, including Sardinia and Sicily (for a summary see Restivo and Giacobbe, 2010). At present, at least two small breeding populations are known in Italy, one of which in the surroundings of Caserta and one in Eboli (Susana Saavedra in litt. 2017). The species has been present in France, at least since 1987, and occasional breeding was reported (Dubois 2007, Hans 1992), but the species is not considered established (Dubois and Cugnasse 2015, CABI 2014). The presence of the species was recorded also in Belgium for at least 4 years, e.g. from 2005 to 2008; in particular 3 breeding attempts were reported in 2006, of which 2 were successful (Bosmans 2009). Birds were observed foraging in short grassland, young corn fields or roadside verges. They regularly fed on cat food near houses and were also observed feeding on ants and berries of rowan (*Sorbus aucuparia*) (Bosmans 2010). The current status of common myna in Belgium is casual, with frequent casual observations of escaped birds reported by birders since 2000. In The Netherlands, successful breeding (3 young) of escaped cagebirds was observed in 1984 at the Veluwemeer lake, but such records are exceptional

		(SOVON Vogelonderzoek Nederland 2002). The last published record of *A. tristis* is from 2009 (Lensink et al. 2013). Occasional records of the Common Myna in Germany are known since 1906, when a single specimen was shot after living in the wild for some time (Moritz 1975). Between 1971 and 1999 several escapees from private owners have been documented, including temporary breeding attempts (Bauer and Woog 2008). The current status of the species in Germany is "casual" (Rabitsch et al. 2015). In Austria two individuals were recorded in 2010 in a city park in Styria, but apparently have disappeared (Albegger et al. 2015). The current status is most likely "absent". In Poland there is one record of 2003 (Wojciech Solarz, in litt. 2018, see also http://komisjafaunistyczna.pl/?page_id=44) The species was also recorded once in Slovenia in 2009 (Hanžel, J. & D. Šere, 2011), in Finland in 2014 (personal communication by Lauri Urho) and in Sweden in 2018 (personal communication by Henrik Lange).
Ch.4 In which EU member states has this species established populations? List them with an indication of the timeline of establishment and spread.	Established populations are currently known in Portugal (Saavedra et al. 2015) and Italy (Susana Saavedra in litt. 2017).	
Ch.5. In which EU member states could the species establish in the future under current climate and under foreseeable climate change?	A comprehensive analysis of suitability for potential establishment of *Acridotheres tristis* in Europe, under current and predicted future climatic conditions was made for the purpose of this risk assessment (see Annex IV). The results of the study show that under current climate conditions the species may become established in Mediterranean Biogeographical Region, e.g. in	Common Mynas are originally from tropical and subtropical climates hence severe winters may be the most limiting factor. Therefore, further warming of the climate due to climate change, may benefit the species in colonising new areas, i.e. by the 2070s, climate change is predicted to increase suitability in the 'already-suitable' region of Europe and also expand the

	Portugal, Spain, France, Italy, Greece, and Croatia. Under future foreseeable climate change the species could become established also in northern areas (possibly in most EU countries, see Annex IV for details).	suitable region northwards (see Annex IV).
Ch.6. In which EU member states has this species shown signs of invasiveness?	Portugal and Spain (see Saavedra et al. 2015)	
Ch.7. In which EU member states could this species become invasive in the future under current climate and under foreseeable climate change?	A comprehensive analysis of suitability for potential establishment of *Acridotheres tristis* in Europe, under current and predicted future climatic conditions was made for the purpose of this risk assessment (see Annex IV). The results of the study show that under current climate conditions the species may become established (hence potentially invasive) in Mediterranean Biogeographical Region, e.g. in Portugal, Spain, France, Italy, Greece, Croatia. Under future foreseeable climate change the species could become established (hence invasive) also in northern areas. However this would require further studies. As a remark, according to the spatial distribution model in Annex IV, the species could establish in all EU Member States, with the possible exception of the Czech Republic (not suitable) and Finland (only marginally suitable), but certainty for these predictions is low.	Common Mynas are originally from tropical and subtropical climates hence severe winters may be the most limiting factor. Therefore, further warming of the climate due to climate change, may benefit the species in colonising new areas, i.e. by the 2070s, climate change is predicted to increase suitability in the 'already-suitable' region of Europe and also expand the suitable region northwards (see Annex IV).

SECTION A – Organism Information and Screening		
Organism Information	**RESPONSE**	**COMMENT**
A1. Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	Scientific name: *Acridotheres tristis* (Linnaeus 1766) Taxonomy: Class: Aves Order: Passeriformes Family: Sturnidae Rafinesque, 1815 Genus: Acridotheres Vieillot, 1816 Synonyms: *Acridotheres tristas* (Linnaeus, 1766), *Paradisea tristis* (Linnaeus, 1766), *Sturnus tristis* (Linnaeus, 1766). Common names: common myna, common mynah, Indian myna	No varieties or breeds are known, while hybrids of *A. tristis* x *A. cristatellus* are documented (Saavedra S. pers. comm. 2017). The species includes the following subspecies: - *Acridotheres tristis melanosternus* Legge, 1879 from Sri Lanka - *Acridotheres tristis tristis* (Linnaeus, 1766) widespread in south and southeast Asia but also established from escapes in east China, central Japan and Taiwan (Brazil 2009).
A2. Provide information on the existence of other species that look very similar	*Acridotheres tristis* is about the same size (22-25 cm) and superficially resembles the Common Starling *Sturnus vulgaris*. However, the birds are typically brown with a greyish-black hood and the combination of the whitish vent, yellow legs and bill and naked yellow facial skin around the eye are distinctive. In flight, white underwing coverts and a white wing patch on the upper coverts are characteristic (Robson 2002).Other species of the genus *Acridotheres*, including the popular Hill Myna *Gracula religiosa*, may look similar and are either established in Europe (*A. cristatellus*) or frequently kept in cages or bird collections (*A. grandis*, *A. fuscus, A. ginginianus*) and regularly escape. Of these, Bank Myna also have bare skin around the eye, but more reddish-yellow than *A. tristis* and the birds are blue-grey in colour with a black head (Brazil 2009). Great Myna (white-vented myna) *A. grandis* has a distinctive crest. Glossy Starlings	The Crested Myna (*A. cristatellus*) is a similar and closely related species introduced in Europe as well. In Portugal it has undergone an exponential population growth in the last decade, in the same area where the Common Myna occurs (Saavedra et al. 2015). The Crested Myna was recorded also in Spain (Saavedra et al. 2015), Germany (Bauer and Woog 2008), Belgium (Bosmans 2009) and Austria (Kresse and Kepka 1988). In Belgium, in addition to casual observations, some crested mynas were observed to breed (Prosperpolder, Doel) for several years (2004-2006). These birds were captured and removed in 2011 (Vermeersch et al. 2006). The occurrence of a third species, the Bank Myna (*A. ginginianus*), was recorded in Italy where the breeding of a pair was documented in 2003 (Puglisi et al. 2009), and in the Netherlands (Zuid-Beveland 1985) (Vergeer and Van Zuylen 1994). Casual records are known for

	(*Lamprotornis* spp.) escape regularly but they are striking: mostly dark and strong shiny blue or green. The Pied Myna (*Sturnus contra*) has a red-based yellow bill but is black and white (Feare and Craig 1998).	Portugal and Spain, including in the Canary Islands (Saavedra et al. 2015), for Germany (one observation in 1937 and one in 1999) (Nehring and Rabitsch 2015), the Netherlands (Vergeer and Van Zuylen 1994) and Belgium in 2016 (M. Mortier, waarnemingen.be). The fourth species, the Jungle Myna (*A. fuscus*), was observed in Germany in the wild in 1976 for a short period of time (Nehring and Rabitsch 2015).
A3. Does a relevant earlier risk assessment exist? (give details of any previous risk assessment and its validity in relation to the EU)	No specific risk assessments are known for the species in Europe, however an impact assessment is available and valid for Germany (Rabitsch et al. 2015), resulting the species being considered "potentially invasive". A risk assessment was made in Queensland (Australia), resulting in the Common Myna being considered an extreme threat species (Markula et al. 2016). The map of Australia included in the risk assessment shows the partial suitability of the Mediterranean climate area for the species (Markula et al. 2016).	In Queensland, the species is not a prohibited or restricted invasive animal under the Biosecurity Act 2014 (although, by law, everyone has a general biosecurity obligation to minimise the risks associated with invasive species under their control). Local governments must have a biosecurity plan that covers invasive species in their area (see https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/health-pests-weeds-diseases/pests/invasive-animals/other/indian-myna).
A4. Where is the organism native?	The Common Myna originated from Central Asia and Afghanistan through India to south-eastern Asia. The species range is naturally expanding northwards in Central and Southwest Asia, including into southern Russian states. More in detail, according to Feare and Craig (1998) and BirdLife International (2016) the species is considered native in Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Iran, Kazakhstan, Laos, Malaysia, Myanmar, Nepal, Pakistan, Singapore, Sri Lanka, Thailand, Vietnam. However, around the borders of the species' native range some of the factors that underlie distribution change become blurred, making it difficult to distinguish natural spread from human-mediated introduction (CABI 2014). As highlighted by Martin (1996) the large native range of this tropical and subtropical Asian bird, spans a variety of climatic and topographic zones, which has	

	also been implicated in its success as an invader throughout the world. Common Mynas are originally from tropical climates but have a surprising ability to adapt to a wide range of climates (Brochier et al. 2010). In their native range they inhabit flood plains, grasslands, cultivated areas, plantations, as well as desert oases and foothills of various mountainous ranges (Feare and Craig 1998). *Acridotheres tristis* occurs in open areas, scrub, cultivation and urban areas, up to 1525 m (Robson 2002). The birds often rely on buildings in urban areas and cities for roosting in large flocks. In its native range, *A. tristis* breeds year round and is a multi-brooded species (i.e. they have a relatively long breeding season and females lay several clutches with a midseason peak in clutch size (Gil-Delgado 2005)).	
A5. What is the global non-native distribution of the organism (excluding the Union, but including neighbouring European (non-Union) countries)?	The species occurs in all continents except South America and Antarctica, including a number of islands in the Indian, Atlantic and Pacific oceans (Peacock et al. 2007, Parkes 2006). The earliest introductions occurred in the 18th century, on the island of Mauritius and Réunion, where the species was deliberately brought from India and released (CABI 2014). Since then, according to Saavedra et al. (2015) it has been introduced in at least 15 continental countries and 17 archipelagos (including within the EU). In particular, established populations are present in southern Africa and Egypt, Middle East, Madagascar, Australia, New Zealand, United States (Florida), along with a number of oceanic islands and archipelagos, e.g. Réunion, Mauritius, Rodriguez, Comores, Seychelle, St Helena and Ascension Island, Fiji, Tonga, Hawaii, etc. (for a comprehensive review see Feare and Craig 1998, CABI 2014). The species is also established in the arid areas of Asia (Zhang et al. 2016) and in the Arabic peninsula (Soorae 2015), confirming the adaptability to extreme climate conditions. In relation to countries close to the EU, there are known breeding populations in Russia	According to Dyer et al. (2016), the countries (other than the EU) where alien populations of *A. tristis* occur, are the following: American Samoa, Argentina, Australia, Bahrain, Botswana, British Indian Ocean Territory, Brunei Darussalam, Comoros, Cook Islands, Fiji Island, French Polynesia, Georgia, Hong Kong, India, Indonesia, Islamic Republic Of Iran, Iraq, Israel, Japan, Jordan, Kazakhstan, Kiribati, Kuwait, Lesotho, Madagascar, Malaysia, Maldives, Marshall Islands, Mauritius, Mayotte, Mozambique, New Caledonia, New Zealand, Oman, Papua New Guinea, Qatar, Reunion, Russian Federation, Saint Helena, Samoa, Saudi Arabia, Seychelles, Singapore, Solomon Islands, South Africa, Swaziland, Taiwan (Province Of China), Thailand, Turkey, United Arab Emirates, United States, United States Minor Outlying Island, Uzbekistan, Vanuatu, Vietnam. However, the overall situation is quite dynamic, and the species distribution at either the local or regional level is variable considering that while new alien populations become established (including by expanding their range unaided), others disappear, also following the implementation of eradication/control

	(Gillings 1997), and in the Middle East, where it was introduced since the early 1970s (Holzapfel et al. 2006). In Turkey, the species was first recorded in 1996 (Bilgin, 1996), when the first breeding event was observed in Ankara. Bilgin (1996) also mentions the existence of a colony in Georgia (in Batumi, on the Black Sea coast).	programmes.
A6. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in the world?	Yes	Data on the species invasiveness are numerous for Australia (see Markula et al. 2016). But the species is considered invasive in all countries where alien populations are established, including in the EU.
A7. Describe any known socio-economic benefits of the organism in the risk assessment area.	No socio-economic benefits are known in the risk assessment area other than the value of the species as a cage bird (no information on numbers in captivity is available though), and the aesthetic appeal that the species might have for bird-watchers and members of the wider general public.	Some benefits are reported outside the risk assessment area. For example, in its native range in India the Common Myna is referred to as the farmer's friend because it protects crops by feeding on insect pests (GISD 2017). Additionally, the Common Myna (and some other mynas, like the Indian Hill Mynas, *Gracula religiosa*), are accomplished mimics and can learn to talk. For this reason mynas have been traded in many parts of the world as cage birds (Tidemann 2009). Positive impacts concerning the pollination of flowers, especially of trees, are also reported (Sengupta 1976), e.g. *A. tristis* was reported as the most important pollinator of African tuliptree *Spathodea campanulata* (Rangaiah et al. 2004) and feijoa (pineapple guava) *Acca sellowiana* (Stewart 1987). Additionally, a survey made in the Fiji Islands (Prasad and Christi 2014) highlighted that 38% of the interviewees identified the benefits of myna that includes: help in waking up in the morning, eating harmful insects, myna itself is a source of food (only in times of shortage of food) and contributes in the dispersing fruit seeds like pawpaw, guava and chilli. As a frugivore, *A. tristis* is also reported as seed dispersing birds, e.g. in New Zealand forests (Clout and Hay 1989).

SECTION B – Detailed assessment **Important instructions:** • In the case of lack of information the assessors are requested to use a standardized answer: "No information has been found." • For detailed explanations of the CBD pathway classification scheme consult the IUCN/CEH guidance document. • With regard to the scoring of the likelihood of events or the magnitude of impacts see Annex • With regard to the confidence levels, see Annex.			
PROBABILITY OF INTRODUCTION and ENTRY			
Important instructions: • Introduction is the movement of the species into the risk assessment area, i.e. the Union territory excluding the outermost regions. • Entry is the release/escape/arrival in the environment, i.e. occurrence in the wild. Not to be confused with spread, the movement of an organism within the risk assessment area. • For organisms which are already present in the risk assessment area, only complete this section for current active or if relevant potential future pathways. This section need not be completed for organisms which have entered in the past and have no current pathway of introduction and entry.			
QUESTION	**RESPONSE [chose one entry, delete all others]**	**CONFIDENCE [chose one entry, delete all others]**	**COMMENT**
1.1. How many active pathways are relevant to the potential entry of this organism? (If there are no active pathways or potential future pathways respond N/A and move to the Establishment section)	moderate number	high	See below
1.2. List relevant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways as well as a description of the associated commodities. For each pathway answer questions 1.3 to 1.10 (copy and paste additional rows at the end of this section as necessary). Please attribute unique identifiers to each question if you consider more than one pathway, e.g. 1.3a, 1.4a, etc. and then 1.3b, 1.4b	1) Pet/aquarium/terrarium species (escape from confinement) 2) Hitchhikers on ship/boat (transport stowaway) 3) Botanical garden/zoo/aquaria		Global spread has occurred through natural expansion, and by deliberate and accidental introductions. In Europe, the main active pathways are possibly the pet trade, the human assisted transport through ships and ferries, and the escapes from zoological facilities. Outside of Europe, a major cause of introduction, has often been the release for the control of pest insects species The species has been subject to "other intentional releases"

etc. for the next pathway.	(escape from confinement) 4) Unaided (Natural dispersal across borders of invasive alien species that have been introduced)		through a number of pathways, some of which are not considered active anymore or are not relevant for the risk assessment area, hence have not been further discussed in this risk assessment. They are briefly described below for providing a complete overview: a) Release for biological control: Common Mynas were often deliberately introduced to control insect plagues (Saavedra et al. 2015). For example, the Common Myna was introduced in Tahiti around 1910 to reduce wasp numbers (Thibault, 1988) and to Madagascar to reduce locust (*Locusta migratoria*) infestations (JYM 1998). In Hawaii, the Common Myna was introduced to remove cutworms and army worms from sugar cane (Kurdila 1995). Also in the Middle East, the species was introduced in large numbers from the early 1970s as a biological control agent (Holzapfel et al. 2006). b) Intentional release by acclimatisation societies was an important pathway in the past, for example in Australia and New Zealand (CABI 2014). c) The same applies to 'prayer release' or 'merit release' of captive birds, which are widely practiced by Chinese inhabitants, particularly Buddhists. This practise might have facilitated the deliberate release of Common Mynas in Hong Kong and Taiwan and has been considered a risk for dispersal of alien species (see Gilbert et al. 2012, CABI 2014). d) Also, Common Mynas were introduced to the Andaman Islands around 1867 and possibly also to the Nicobars supposedly as scavengers to assist in the removal of rubbish (CABI 2014). e) In Israel, as suggested by this article http://www.timesofisrael.com/israels-other-air-defense-problem/ mynas may have been released in the 1950s by staffers at the Mikveh Israel agricultural school, near Tel Aviv, thinking the country would benefit from the addition of a pretty tropical species. This may qualify as "Landscape/flora/fauna "improvement" in the wild" but it is not considered as an active release pathway in Europe.

Pathway name:	[Pet/aquarium/terrarium species (escape from confinement)]		
1.3a. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)	intentional	very high	The species is imported for trade, and as such the pathway is intentional. Saavedra et al. (2015) explain the species' successful establishment in Spain and Portugal by the accidental escapes of birds wild–caught from their native range (see also Carrete and Tella, 2008).
1.4a. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place. Subnote: In your comment discuss the volume of movement along this pathway.	moderately likely	medium	The pet trade is possibly a main pathway for the species in Europe. The Common Myna has been traded worldwide as a cage–bird species and, as pointed out by Saavedra et al. (2015), there is a continuous risk of intentional introductions into the risk assessment area, because these birds are available in pet shops in several European countries (see also Carrete and Tella, 2008). According to Saavedra et al. (2015) despite a national trade ban, mynas were offered for sale in Portuguese and Dutch pet–shops and online through specialized websites, and were directly shipped to Spain without administrative control. However, detailed information on the number of birds that are kept in captivity in the risk assessment area is not available. Similarly, reliable data on number of birds that were released or did escape are lacking (this is a problem already noticed also in other countries, as reported for Israel and the Middle East, see Holzapfel et al. 2006). This pathway may facilitate reinvasion after eradication: despite eradication efforts of established breeding populations on four Spanish islands (see details in Saavedra, 2010), one pair was again breeding in Tenerife in 2013 and one individual appeared on another Canary island (Lanzarote) in 2013 (Saavedra et al. 2015). However, it is not clear which pathways were actually involved.
1.5a. How likely is the organism to survive during passage along the pathway (excluding management practices that would			N/A

kill the organism)? Subnote: In your comment consider whether the organism could multiply along the pathway.			
1.6a. How likely is the organism to survive existing management practices during passage along the pathway?			N/A
1.7a. How likely is the organism to enter the risk assessment area undetected?			N/A
1.8a. How likely is the organism to arrive during the months of the year most appropriate for establishment?	likely	high	N/A
1.9a. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	likely	high	The Common Myna is considered very good at adapting to local environments (GISD 2017), particularly in man made habitats. Therefore it is likely that following escape (or release) from captivity, it could quickly and easily locate suitable foraging and nesting/roosting habitats (e.g. in parks and (sub)urban habitats).
1.10a. Estimate the overall likelihood of entry into the risk assessment area based on this pathway?	very likely	very high	In current conditions, the overall likelihood of entry into the EU through this pathway is very high. The species has already been recorded in eight countries (although managed to get established only in three), possibly as a consequence of this pathway, and is traded in many others.
End of pathway assessment, repeat as necessary.			

Pathway name:	[Hitchhikers on ship/boat (transport stowaway)]		
1.3b. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)	unintentional	high	Introduction as hitchhikers on ships is unintentional. No data are available for the species introduction through this pathway in Europe. However, it is possible that some EU islands may be colonised through this pathway, based on the evidence that on oceanic islands, the invasion pathways

			appear to be primarily via ships, particularly large ferries (GISD 2017). Hence, this pathway is considered potentially active in the EU.
1.4b. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place. Subnote: In your comment discuss the volume of movement along this pathway.	unlikely	low	In current conditions, the expected volume of movement of Common Mynas by ship-assisted transfer to the EU is minimal. As reported in GISD (2017) the introduction of the species through this pathway is documented (in countries other than EU Member States), but no figures are available on shipping volumes (cargo and passenger vessels) and number of individuals moved through this pathway. This pathway may of course facilitate reinvasion after eradication, but this depends on the presence of source populations along the relevant ship routes. Reinvasion after eradication is possibile: despite eradication efforts of established breeding populations on four Spanish islands (control campaigns were conducted on these incipient breeding populations between 1999 and 2008, according to Saavedra et al. 2015, and Saavedra, 2010), one pair was again breeding in Tenerife in 2013 and one individual appeared on another Canary island (Lanzarote) in 2013 (Saavedra et al. 2015). However, it is not clear which pathways were actually involved.
1.5b. How likely is the organism to survive during passage along the pathway (excluding management practices that would kill the organism)? Subnote: In your comment consider whether the organism could multiply along the pathway.	likely	low	The introduction along this pathway of the Common Myna - as well as other Passeriformes, e.g. the House crow (*Corvus splendens*) - is documented (in countries other than EU Member States), therefore the species may well survive during passage along this pathway. Breeding attempts during transport are extremely unlikely.
1.6b. How likely is the organism to survive existing management practices during passage along the pathway?	N/A		No information has been found. There are no known specific practices for preventing Common Mynas gaining access to ships at ports of origin, surviving onboard or alighting at

			ports of entry (destination).
1.7b. How likely is the organism to enter the risk assessment area undetected?	unlikely	high	Escaped individuals are unlikely to remain undetected for a long period of time. Individuals should quickly be detected by the birdwatching community, and promptly reported (at least within their relevant networks), however some birdwatchers may ignore alien species (it is widely recognised that many alien species are under-recorded). For example, according to Holzapfel et al. (2006) some countries of the Middle East have been colonized only very recently, however the possibility that this species has been overlooked in the past prior to the surge in birdwatching activity cannot be disregarded. There is some possibility of this problem being relevant also within the EU.
1.8b. How likely is the organism to arrive during the months of the year most appropriate for establishment?	likely	low	Not certain whether any particular time of the year is more appropriate for establishment than others. It is likely that in south-European countries, depending on the local climatic and environmental factors, it could establish during any month of the year. As ship travel may occur throughout the year, the likelihood of the species being introduced at the right time is supposed to be high.
1.9b. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	likely	high	*Acridotheres tristis* is considered very good at adapting to local environments (GISD 2017), particularly in man made habitats. Therefore it is likely that, following human assisted transport on a ship, it could quickly and easily locate suitable foraging and nesting/roosting habitats (e.g. in harbour surroundings, (sub)urban areas, parks).
1.10b. Estimate the overall likelihood of entry into the risk assessment area based on this pathway?	very unlikely	low	In current conditions, the overall likelihood of entry into the EU based on this pathway is minimal.
End of pathway assessment, repeat as necessary.			

Pathway name:	[Botanical garden/zoo/aquaria (escape from confinement)]		
1.3c. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a	intentional	very high	The species is kept in zoological facilities, and as such the pathway is intentional. However, entry into the wild through

contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)			this pathway is mostly associated to unintentional escapes. According to an unofficial inventory of European zoos and public collections the species currently is on display in Germany (7 zoos), Netherlands (2), Austria (1), Poland (1), Spain (1), Great Britain (2) and Cyprus (1) (zootierliste.de). The data collected in Spain confirm the escape from a zoo in Fuerteventura and in another Spanish island (Saavedra et al. 2015). According to Holzapfel et al. (2006) it is conceivable that the first Israeli birds in the Tel Aviv region originated from escapes from a bird zoo.
1.4c. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place. Subnote: In your comment discuss the volume of movement along this pathway.	unlikely	high	In current conditions, the expected volume of Common Mynas entries into the wild through zoo escapes within the EU is low. Detailed information on the number of birds that are kept in captivity is not available, but is expected to be very low. Similarly, reliable data on number of birds that were released or did escape from zoos are generally lacking. Similarly, the possibility that this pathway will facilitate reinvasion after eradication should be considered low.
1.5c. How likely is the organism to survive during passage along the pathway (excluding management practices that would kill the organism)? Subnote: In your comment consider whether the organism could multiply along the pathway.			N/A
1.6c. How likely is the organism to survive existing management practices during passage along the pathway?			N/A
1.7c. How likely is the organism to enter the risk assessment area undetected?			N/A
1.8c. How likely is the organism to arrive during the months of the year most appropriate for establishment?			N/A

1.9c. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	likely	high	The Common Myna is considered very good at adapting to local environments (GISD 2017), particularly in man made habitats. Therefore it is likely that following escape (or release) from captivity, it could quickly and easily locate suitable foraging and nesting/roosting habitats (e.g. in /sub)urban areas and parks).
1.10c. Estimate the overall likelihood of entry into the risk assessment area based on this pathway?	moderately likely	medium	In current conditions, the overall likelihood of entry into the EU through this pathway is minimal.
End of pathway assessment, repeat as necessary.			

Pathway name:	[Unaided (Natural dispersal across borders of invasive alien species that have been introduced)]		
1.3d. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)	unintentional	high	Once introduced in any EU neighbouring country, the species may be able to enter into the EU unaided by flying over short distances (but dispersal over large distances is also possible). This secondary spread pathway is unintentional.
1.4d. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place. Subnote: In your comment discuss the volume of movement along this pathway.	unlikely	low	The introduction of the species into the risk assessment area, from outside the EU through this pathway is possible, which is based on some documented evidence in countries other than EU Member States (but figures are not available) and the fact that the actual situation in some neighbouring countries (e.g. Turkey, Russia) is not clear. Also the possibility that this pathway will facilitate reinvasion after eradication should be considered low, because this depends on the presence of source populations in neighbouring countries. For example, around the borders of the species' native range sometimes it is difficult to distinguish natural spread (e.g. facilitated by agricultural and urban development) from artificial introduction (a number of examples are reported in CABI 2014). The species spread on large landmasses, including within

			large islands, may be facilitated by human infrastructures such as roads (CABI 2014). In Australia, New South Wales, for example, the dispersal of Common Mynas has been facilitated by the birds using roads and maybe railways as corridors to towns previously uncolonized, although this evidence could be biased to the the fact that such sites are usually most intensely surveyed (Hone 1978). Similarly, in South Africa the species seems common along major roads (Peacock et al. 2007).
1.5d. How likely is the organism to survive during passage along the pathway (excluding management practices that would kill the organism)? Subnote: In your comment consider whether the organism could multiply along the pathway.	likely	high	The introduction of the species through this pathway is documented (in countries other than EU Member States), but details are not available. Dispersal capacity can be high: one ringed bird was recovered 381 km from its capture site in little more than a year in South Africa (Oschadleus 2001).
1.6d. How likely is the organism to survive existing management practices during passage along the pathway?	moderately likely	low	It is known that after the control campaigns carried out in Tenerife, Gran Canaria, Fuerteventura and Mallorca between 1999 and 2008 (Saavedra et al. 2015), a few individuals were left alive. However, the eradication succeeded, and eventually all individuals disappeared the year after (although some individuals were probably introduced again, either intentionally or not, or arrived through unaided spread).
1.7d. How likely is the organism to enter the risk assessment area undetected?	unlikely	high	Introduced individuals are unlikely to remain undetected. Individuals would probably be quickly detected by the birdwatching community, and promptly reported (at least within their relevant networks), however some birdwatchers may ignore alien species (it is widely recognised that many alien species are under-recorded). For example, according to Holzapfel et al. (2006) some countries of the Middle East have been colonized only very recently, however the possibility that this species has been overlooked in the past prior to the surge in birdwatching activity cannot be disregarded. There is some possibility of this problem being relevant also within the EU.

1.8d. How likely is the organism to arrive during the months of the year most appropriate for establishment?	likely	low	Not certain whether any particular time of the year is more appropriate for establishment than others. It is likely that in south-European countries, depending on the local climatic and environmental factors, it could establish during any month of the year.
1.9d. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	likely	high	Considering the high diversity of habitats suitable for the species, then it could easily locate suitable foraging and nesting/roosting habitats.
1.10d. Estimate the overall likelihood of entry into the risk assessment area based on this pathway?	Moderately likely	medium	There are no known populations at the border of any EU Member States, but actual situation in some neighbouring countries (e.g. Turkey, Russia) is not clear, therefore there is a minimal risk of the species being able to enter the EU.
End of pathway assessment, repeat as necessary.			

1.11. Estimate the overall likelihood of entry into the risk assessment area based on all pathways in relevant biogeographical regions in current conditions (comment on the key issues that lead to this conclusion).	very likely	very high	The species is already present in the EU, in two countries of the Mediterranean biogeographical region, but its occurrence is still very localised. In terms of Biogeographical Regions, those predicted to be most suitable for *A. tristis* establishment in the current climate are the Mediterranean, plus the Steppic, Black Sea, and (at least in part) Alpine Biogeographical regions (see Annex IV). Hence the range of suitable habitats within the EU, along with the active pathways in the risk assessment area, increase the risk of further successful introductions and entries into the wild in areas not yet colonised. For example, there is evidence that the species is still traded as pet (Saavedra et al. 2015), and it is still kept in zoos (zootierliste.de). Besides, the species may spread through human assisted transport and is capable to spread unaided. In the Mediterranean (and Macaronesian, outside the RA area) biogeographical regions, for example, since the early 1990s a study carried out with a focus on the Iberian peninsula only (including three archipelagos) showed that there have been at least 22 independent accidental introductions of three myna species (Saavedra et al. 2015).
1.12. Estimate the overall likelihood of entry into the risk assessment area based on all pathways in relevant	very likely	very high	*Acridotheres tristis* is originally from tropical and subtropical climates hence severe winters may be the most limiting

biogeographical regions in foreseeable climate change conditions?			factor. Therefore, further warming of the climate due to climate change, may benefit the species in colonising new areas, i.e. by the 2070s, climate change is predicted to increase suitability in the 'already-suitable' region of Europe and also expand the suitable region northwards (see Annex IV).

PROBABILITY OF ESTABLISHMENT			
Important instructions: • For organisms which are already established in parts of the Union, answer the questions with regard to those areas, where the species is not yet established. If the species is established in all Member States, continue with Question 1.16.			
QUESTION	**RESPONSE**	**CONFIDENCE**	**COMMENT**
1.13. How likely is it that the organism will be able to establish in the EU based on the similarity between climatic conditions in Europe and the organism's current distribution?	very likely	very high	Climatic conditions in the EU, particularly in the Mediterranean (and Macaronesian) regions, are similar to those found in the sites of Portugal, Spain and Italy where the species formed established breeding populations (although in some Spanish islands it was successfully eradicated). In fact, in terms of Biogeographical Regions, those predicted to be most suitable for *A. tristis* establishment in the current climate are the Mediterranean, plus the Steppic, Black Sea, and (at least in part) Alpine Biogeographical regions (see Annex IV). It is known that Common Mynas are able to adapt to a wide range of climates and habitats: they are found in both tropical and temperate regions, from the tropics to southern Europe (Russia) and to northern France (GISD 2017), Belgium (Bosmans 2009) and the Netherlands (SOVON Vogelonderzoek Nederland 2002). It is also known that the species prefers warm to hot climates (Markula et al. 2016) and that Common Mynas are generally absent from areas where the average minimum temperature of the coldest month is lower than –0.4˚C (which may lead to the lack of sufficient food resources invertebrates for nestling, see Markula et al. 2016). The occurrence of the species in western and central Europe (e.g. Belgium, France and Germany, where small populations lasted several years) shows that

			individuals can survive in colder climates (although this does not necessarily indicate that they can establish self-sustaining populations, see Holzapfel et al. 2006). Therefore, while the Common Myna already showed to be able to establish wild populations under the Mediterranean and Macaronesian climate, the suitability of colder climate zones cannot be automatically excluded, particularly thanks to the adaptive behavior which is a characteristic of the species. For example, in New Zealand, the Common Myna tends to avoid colder regions in the south; but interestingly it can establish stable populations near piggery sheds where sufficient heat is produced by the pigs to maintain a relatively high temperature; in addition there is an abundance of pig food available (GISD 2017).
1.14. How likely is it that the organism will be able to establish in the EU based on the similarity between other abiotic conditions in Europe and the organism's current distribution?	likely	high	Many studies have shown that the species finds urban and suburban environments (along with several types of anthropogenically modified habitats, such as cultivated land) as particularly suitable (see for example the result of a study by Old et al (2014) showing the suitability of urban habitats in Australia, or a study by Lim et al. (2003) showing that in Singapore the Common Myna was associated closely with agricultural areas. This was confirmed also though a study carried out in the city of Canberra, Australia, where Common myna abundance was almost three times higher in urban areas than nature reserves and declined rapidly as tree density in nature reserves increased (Grarock et al. 2014). According to GISD (2017) in many areas of its introduced range the Common Myna reaches the highest densities in modified habitats near human establishments, including cities, towns, villages, farmland, rural dwellings, parks, gardens and roadsides. According to a study by Sol et al. (2011) undertaken in Australia, mynas from highly urbanized environments showed a higher propensity to innovate than those from

			less urbanized environments. In particular, two main drivers (neophobia and exploration) seem readily adjusted based on experience to suit prevailing ecological conditions, which may help us understand the great success of the species in highly urbanized environments (Sol et al. 2011). This is consistent with the reports for Portugal, where breeding populations are present in the urbanized areas of Lisbon, Belem, Cascais, Oeiras, Corroios and Caparica (Saavedra et al. 2015). This is consistent also with the reports from South Africa (Peacock et al. 2007) and Israel (Holzapfel et al. 2006). Such habitats are widespread all over the EU, including countries where the species is not yet established.
1.15. How likely is it that the organism will become established in protected conditions (in which the environment is artificially maintained, such as wildlife parks, glasshouses, aquaculture facilities, terraria, zoological gardens) in Europe? Subnote: gardens are not considered protected conditions	very likely	very high	The species is present in European zoos, and escapes from such facilities are also reported (Saavedra et al. 2015). The species currently is on display in Germany (7 zoos), Netherlands (2), Austria (1), Poland (1), Spain (1), Great Britain (2) and Cyprus (1) (zootierliste.de), but the actual existence of breeding stocks is not clear.
1.16. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in Europe?	widespread	high	The Common Myna evolved in open woodland habitats in India (Pell and Tidemann 1997a), and most of its indigenous range lies within the tropics and subtropics. However the species is able to adapt to a wide range of habitats, which can be used to suit its needs. Key habitat types are flood plains, grasslands, cultivated areas, plantations, desert oases, the foothills of various mountain ranges and urban areas (Feare and Craig 1998), but see also CABI (2014) for additional details. For example, a study carried out in Australia (Pell and Tidemann 1997a) has demonstrated that the Common Myna has adapted successfully to climatic conditions, which can include periodically dry summers and

			extreme winters (during which mynas move from the nature reserves to the surrounding suburban areas where they can find refuge). According to Markula et al. (2016) Common Mynas are generally absent from areas where the average minimum temperature of the coldest month is less than –0.4˚C. However, due to its adaptive behavior, they did manage to establish in cold regions in the south of New Zealand, e.g. near piggery sheds where sufficient heat is produced by the pigs and there is an abundance of food available (GISD 2017). Therefore, besides the habitat types where the species already managed to thrive in Europe (particularly in the Mediterranean and Macaronesian regions), many others may be suitable. Additionally, as a generalist the Common Myna does not need any specific species for its survival, development and reproduction.
1.17. If the organism requires another species for critical stages in its life cycle then how likely is the organism to become associated with such species in Europe?	NA	very high	The Common Myna does not require another species for establishment. As cavity nester, mynas need cavities made by other species (e.g. woodpeckers) but as also cavities of other origin can be used, that is hardly a real association.
1.18. How likely is it that establishment will occur despite competition from existing species in Europe?	very likely	high	It is unlikely that competition from existing species in Europe will prevent the establishment of the Common Myna. Although competition dynamics with other species were reported, i.e. for food or nesting sites (e.g. the nesting hole in Belgium where they have bred was later occupied by starling), the Common Myna is unlikely to be out-competed. In fact the invasion success may be partly attributable to behavioural strategies adopted when competing for resources, although the extent to which competition for resources influences the success of Common Mynas is presently unknown (Haythorpe et al. 2012). There is no evidence that the establishment of Common Mynas has been prevented by competition with other species, at least not

			in continental Portugal and Spain, nor in the Spanish islands (from where it was successively eradicated).
1.19. How likely is it that establishment will occur despite predators, parasites or pathogens already present in Europe?	very likely	high	It is unlikely that predation or transmission of parasites and pathogens from existing species in Europe will prevent the establishment of the Common Myna. There are few (if any) natural predators in Europe that are likely to take adult Common Mynas. Common Mynas, however, may be preyed upon by cats and snakes (CABI 2014) and possibly raptors (Markula et al. 2016). Eggs or chicks may be predated by mammals (e.g. Stone Marten), birds and reptiles, especially snakes (see Markula et al. 2016), but this is unlikely to prevent the species' establishment. It is not clear whether any parasites or pathogens exists in Europe, which may prevent the establishment of the species, but the Common Mynas are known to carry diseases that may not affect them directly, while may have a serious impact on native species, as with the case of the Avian Malaria (Markula et al. 2016, Clark et al. 2015).
1.20. How likely is the organism to establish despite existing management practices in Europe?	likely	high	No specific management practices are in place in Europe, which may contribute to prevent the establishment of the Common Mynas. Eradication campaigns have been carried out sporadically in Spain only, in the Canary and Balearic Islands (Saavedra et al. 2015). In this case, despite the eradication achieved in four Spanish islands (see details in Saavedra, 2010), in 2013 one pair was again breeding in Tenerife and one individual appeared in Lanzarote. The species eventually disappeared since then (Juan Luis Rodríguez Luengo and Joan Mayol , pers. comm. 2017) According to Saavedra et al. (2015) eradication

			campaigns may be not sufficient to avoid the establishment and spread of mynas if they are not combined with sound preventive measures (e.g. trade regulations, etc.). The Common Myna is likely to get established mostly in urban and suburban habitats, thus lethal control operations targeting birds in such environments may be affected by technical and ethical constrains (although there could be a cry for myna control as numbers build up and large flocks start roosting and defecating on buildings). Also, there is no evidence that operations usually carried out in urban centres to disperse Common Starlings (*Sturnus vulgaris*), e.g. by means of scaring devices (such as recording of distress or alarm calls) would have any effect on Common Mynas (in fact this is not a method for population management but rather for damage control and, as with any scaring device, birds may quickly get used to it).
1.21. How likely are existing management practices in Europe to facilitate establishment?	likely	high	Many studies have shown that the species finds urban and suburban environments (along with several type of anthropogenically modified habitats, such as cultivated land) as suitable. It is therefore likely that the current urbanization trend occurring in Europe may favor the establishment of the species. This is consistent with Holzapfel et al. (2006) who reported the habitats used by Common Myna in Israel and other parts of the Middle East. This demonstrates its preference for areas undergoing major land-use change, typically large, irrigated grass lawns interspersed with trees and artificial structures like street and traffic lights (which reflects the habitat preference of the species in its native range, see Feare and Craig 1998).
1.22. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in Europe?	moderately likely	high	The species could be relatively easy to contain within the area of establishment, but only if control is undertaken while numbers are relatively small and their

			range restricted (Edelaar and Tella 2012, Saavedra et al. 2015). Otherwise, a common reason for unsuccessful eradications, e.g. in Seychelles, is the failure to detect the last remaining animals or to detect reinvasions by small numbers (Feare et al. 2017). In addition, reproductive capacity of the species is high. Females lay 2-6 eggs per clutch and 1-3 clutches per year. Birds reach sexual maturity within their first year of age (Markula et al. 2009).
1.23. How likely are the biological characteristics of the organism to facilitate its establishment?	likely	high	According to Saavedra (2010) the Common Myna is a very intelligent bird and highly adaptable to the environmental conditions of the sites where it get established. There are several biological characteristics which make the species a successful invader. Some of them are relative to the breeding biology (Peacock et al. 2007). Common Mynas are monogamous and pairs use the same territory each year. Nests are built in hollows in either trees or many other places, including human infrastructures (see Holzapfel et al. 2006). The species may breed 1–3 times per year, reaches sexual maturity at 9–12 months, and has an average life span of 4 years in the wild, possibly over 12 years (Markula et al. 2016). Both sexes contribute to incubate the eggs (clutch size is 4-6 eggs, average 4) and feed the young (with invertebrates). In Israel the breeding season occurs between May and August (Holzapfel et al. 2006), but the period can vary across the species range (e.g. in India is April-July, according to Mahabal and Vaidya, 1989). Common Mynas are social birds (a single communal roost can gather together up to 5000 birds). At the same time they maintain territories and defend them aggressively from other birds. The diet of this omnivorous bird is rather flexible, allowing them to take advantage of seasonal/temporary food sources (Markula et al. 2016). While nestling feed almost exclusively on insects and other invertebrates, the

			adult's diet includes eggs and chicks of both terrestrial and marine birds (e.g. Hughes et al. 2017), insects, reptiles, seeds, nectar, etc. *Acridotheres tristis* forages in open, grassy areas, feeding on insects such as grasshoppers, insect larvae, earthworms, fruit, nectar, and animal remains (Sengupta 1976). *Acridotheres tristis* is also an excellent human commensal, able to find food on human waste, crops or areas with cattle or domestic animals (for details see also Feare and Craig 1998, and GISD 2017). All of these requirements would be easily satisfied in Europe.
1.24. How likely is the capacity to spread of the organism to facilitate its establishment?	likely	high	The results of a study in the introduced range in South Africa confirm that this species enhanced the dispersal ability during the range expansion under novel environmental conditions, despite being a relatively poor disperser in both its native range (Berthouly-Salazar et al. 2012) and alien range (Hone 1978). In the Iberian Peninsula a continued growth and spread of the species is expected in the absence of management action (Saavedra et al. 2015). In any case it is worth mentioning that exceptionally long-distance flights are possible, see comment above (Oschadleus 2001).
1.25. How likely is the adaptability of the organism to facilitate its establishment?	very likely	very high	The Common Myna is an extremely adaptive bird which demonstrates a high degree of behavioural flexibility, which may allow the species to adapt to a range of environments. For a review of its adaptability see Feare and Craig 1998, and GISD 2017).
1.26. How likely is it that the organism could establish despite low genetic diversity in the founder population?	likely	medium	No precise information is available on the number of founders of the many introduced populations, and no data are available on the relevant genetic flexibility of the species, but low genetic diversity is not expected to be a problem for the species invasion process.
1.27. Based on the history of invasion by this organism elsewhere in the world, how likely is it to establish in Europe? (If possible, specify the instances in the comments box.)	very likely	high	The species has a very long history of invasion (see CABI 2014 for an updated and exhaustive review) and is already established in Europe, as well as in some

			other Mediterranean countries, like Israel. The experience in other countries worldwide suggests that the risk of the species further spreading in Europe is very high.
1.28. If the organism does not establish, then how likely is it that casual populations will continue to occur? Subnote: Red-eared Terrapin, a species which cannot re-produce in GB but is present because of continual release, is an example of a transient species.	very likely	high	The species is commonly traded and is still kept in zoos, and as such it is likely that escapes of birds from captivity will continue in the future.
1.29. Estimate the overall likelihood of establishment in relevant biogeographical regions in current conditions (mention any key issues in the comment box).	likely	high	The likelihood of establishment of the Common Myna in the Mediterranean, Macaronesian and Anatolian biogeographical regions in current condition is very high (see Annex IV), while in other biogeographical regions it is moderate.
1.30. Estimate the overall likelihood of establishment in foreseeable climate change conditions in a) relevant biogeographical regions in the EU b) neighbouring to the EU countries	likely	high	Common Mynas are originally from tropical and subtropical climates hence severe winters may be the most limiting factor. Therefore, further warming of the climate due to climate change, may benefit the species in colonising new areas, i.e. by the 2070s, climate change is predicted to increase suitability in the 'already-suitable' region of Europe and also expand the suitable region northwards (see Annex IV). The likelihood of establishment of the Common Myna under foreseeable climate change conditions may increase in the all EU biogeographical regions, with the only exception of the Arctic (see Annex IV). In EU neighbouring countries (e.g. in Turkey) it is already present, therefore under foreseeable climate change conditions, the establishment in and spread from neighbouring countries may be likely.

PROBABILITY OF SPREAD			
Important notes: • Spread is defined as the expansion of the geographical distribution of an alien species within the assessment area. • Repeated releases at separate locations do not represent spread and should be considered in the probability of introduction and entry section.			
QUESTION	**RESPONSE**	**CONFIDENCE**	**COMMENT**
2.1. How important is the expected spread of this organism in Europe by natural means? (Please list and comment on each of the mechanisms for natural spread.)	Moderate	**low**	The contribution of human-assisted introductions vs. natural spread is not fully clear, and their relative importance cannot be easily assessed. In Portugal spread has been slow (and so was on the Canary and Balearic islands of Spain where the species was established before being eradicated). Thus, there is no evidence of rapid spread in Europe. However, in the Iberian Peninsula a continued growth and spread of the species is expected in the absence of management action (Saavedra et al. 2015). Also in New Zealand the species spread seemed low (Tindall et al. 2007). But in other countries, the Common Myna appeared to be spreading fast. For example, in the Middle East, particularly in Israel, the extremely short time-lag of just a few years from first occurrence to the rapid spread of the species was quite remarkable (Holzapfel et al. 2006). As reported by Peacock et al. (2007) for Israel it was suggested that agricultural fields may act as stepping-stones to expand the species distribution range from one urban area to another. However, according to Holzapfel et al. (2006) the current spread of the Common Myna in Israel and in most parts of the Middle East was likely triggered by deliberate introductions or by accidentally escaping cage birds and is not likely due to natural range expansion from adjacent areas. The larger geographical pattern of spread does resemble a natural range expansion process.

			Hence, generally speaking, the Common Myna has a relatively low dispersal rate compared to other bird species, with dispersal distances below 16 km (Berthouly-Salazar et al. 2012), although long-distance events have been documented (one ringed bird was recovered 381 km from its capture site in little more than a year in South Africa, Oschadleus 2001). It is clear that the problem is highly context dependent. The results of a study in the introduced range in South Africa confirm that this species enhanced the dispersal ability during the range expansion under novel environmental conditions despite being a relatively poor disperser in the native range (Berthouly-Salazar et al. 2012). In fact according to Peacock et al. (2007), in addition to deliberate introductions by humans, the Common Myna is currently undergoing a natural range expansion at the margins of the native range (e.g. into Singapore, Malaysia and Turkey), probably as a result of extensive clearing of natural vegetation for agriculture and increasing human population densities. van Rensburg et al. (2009) suggest that in southern Africa, and particularly in the Pretoria region, the continued spread and population growth of the Common Myna are the direct result of anthropogenic land transformation toward urbanized habitats (which may be highly relevant for future changes across Europe). The species spread may be facilitated by other human infrastructures. According to CABI (2017), on large landmasses, including within large islands, roads appear to facilitate the spread of the species. In New South Wales for example, a factor in dispersal of Common Mynas has been the use of roads and maybe railways as corridors to towns previously uncolonized, although this evidence could be biased to the the fact that such sites are usually most intensely surveyed (Hone 1978). Similarly, in South Africa

			the species seems common along major roads (Peacock et al. 2007).
2.2. How important is the expected spread of this organism in Europe by human assistance? (Please list and comment on each of the mechanisms for human-assisted spread) and provide a description of the associated commodities.	unlikely	low	There is no evidence that the species would be moved deliberately by humans, or will hitch-hike on ship/vehicles, from the EU countries where it is currently established (e.g. Portugal). Escapes can occur from private citizens due to the pet trade, and from zoos (or other collections of captive birds), and may increase the opportunities for the species to spread in Europe, once introduced in the relevant countries. However these events are likely to be relatively infrequent, and it is likely that only one or two individuals could escape at one time.
2.2a. List and describe relevant pathways of spread. Where possible give detail about the specific origins and end points of the pathways. For each pathway answer questions 2.3 to 2.9 (copy and paste additional rows at the end of this section as necessary).	3) Unaided (Natural dispersal across borders of invasive alien species that have been introduced)		

Pathway name:	[Unaided (Natural dispersal across borders of invasive alien species that have been introduced]		
2.3. Is spread along this pathway intentional (e.g. the organism is released at distant localities) or unintentional (the organism is a contaminant of imported goods)?	unintentional	high	Once introduced in the EU, the species may be able to spread unaided by flying over short distances (but dispersal over large distances is also possible). This secondary spread pathway is unintentional.
2.4. How likely is it that large numbers of the organism will spread along this pathway from the point(s) of origin over the course of one year?	unlikely	low	The spread of *A. tristis* into the EU through this pathway is a possibility, which is based on some documented evidence in countries other than EU Member States (but figures are not available) and the fact that the specie is already present in some Member States. Also the possibility that this pathway will facilitate reinvasion after eradication should be considered low, because this strictly depends on the presence of source populations in the EU countries.

			As documented in countries other than the EU Member States, the species spread on large landmasses, including within large islands, may be facilitated by human infrastructures such as roads (CABI 2014). In New South Wales for example, a factor in dispersal of Common Mynas has been the use of roads and maybe railways as corridors to towns previously uncolonized, though this could be biased because these are the sites of most intense observation (Hone 1978). Similarly, in South Africa the species seems common along major roads (Peacock et al. 2007).
2.5. How likely is the organism to survive during passage along the pathway (excluding management practices that would kill the organism)? Subnote: In your comment consider whether the organism could multiply along the pathway.	likely	high	The introduction of the species through this pathway is documented (in countries other than EU Member States), but details are not available. Dispersal capacity can be high: One ringed bird was recovered 381 km from its capture site in little more than a year in South Africa (Oschadleus 2001).
2.6. How likely is the organism to survive existing management practices during spread?	moderately likely	low	It is known that after the control campaigns carried out in Tenerife, Gran Canaria, Fuerteventura and Mallorca between 1999 and 2008 (Saavedra et al. 2015), a few individuals were left alive. However, the eradication succeeded, and eventually all individuals disappeared the year after (although some individuals were probably introduced again, either intentionally or not, or arrived through unaided spread).
2.7. How likely is the organism to spread in Europe undetected?	unlikely	high	Introduced individuals are unlikely to remain undetected. Individuals should quickly be detected by the birdwatching community, and promptly reported (at least within their relevant networks), however some birdwatchers may ignore alien species (it is widely recognised that many alien species are under-recorded). For example, according to Holzapfel et al. (2006) some countries of the Middle East have been colonized only very recently, however the possibility that this species has been overlooked in the past prior to the surge in birdwatching

			activity cannot be disregarded. There is some possibility of this problem being relevant also within the EU.
2.8. How likely is the organism to be able to transfer to a suitable habitat or host during spread?	likely	high	Not certain whether any particular time of the year is more appropriate for establishment than others. It is likely that in south_European countries it could establish during any month of the year.
2.9. Estimate the overall likelihood of spread into or within the Union based on this pathway?	likely	high	There are already some known populations in the EU Member States, therefore there is a possible risk of the species being able to spread within the EU
End of pathway assessment, repeat as necessary.			

2.10. Within Europe, how difficult would it be to contain the organism?	with some difficulty	medium	As for any other alien species, it depends on the population's invasion stage, availability of human and financial resources, community support and political commitment.
2.11. Based on the answers to questions on the potential for establishment and spread in Europe, define the area endangered by the organism.	The species may get established in the Mediterranean countries (e.g. Spain, Portugal, France, Italy, Greece, Croatia), while under future foreseeable climate change the species could expand the suitable region northwards (see Annex IV).	high	See Questions 3, 4 of the Chapeau.
2.12. What proportion (%) of the area/habitat suitable for establishment (i.e. those parts of Europe where the species could establish), if any, has already been colonised by the organism?	0-10	very high	Established populations are currently known in Portugal (Saavedra et al. 2015) and Italy (Susana Saavedra in litt. 2017.
2.13. What proportion (%) of the area/habitat suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current	0-10	high	The Common Myna has a relatively low dispersal rate compared to other bird species (although long-distance events have been documented), it is present in the pet trade

presence)?			and kept in zoos, however, numbers probably are low and it is not expected that the proportion of invaded area/habitat is changing much within five years from now
2.14. What other timeframe (in years) would be appropriate to estimate any significant further spread of the organism in Europe? (Please comment on why this timeframe is chosen.)	10	medium	The Common Myna has a high reproductive capacity and finds sufficient suitable habitat in the assessment area, and possibly is supported by climate change. However, due to the low dispersal capacity and limited numbers in trade, expansion across Europe in the wild might need a longer time period.
2.15. In this timeframe what proportion (%) of the endangered area/habitat (including any currently occupied areas/habitats) is likely to have been invaded by this organism?	0-10	low	Within 20 years, the proportion of the endangered area/habitat, supported by foreseeable climate change, might increase above 10% of the assessment area.
2.16. Estimate the overall potential for spread in relevant biogeographical regions under current conditions for this organism in Europe (using the comment box to indicate any key issues).	moderately	medium	In Portugal spread has been slow (and so was on the Canary and Balearic islands of Spain where the species was established before being eradicated). Thus, there is no evidence of rapid spread in Europe. However, in the Iberian Peninsula a continued growth and spread of the species is expected in the absence of management action (Saavedra et al. 2015). Also in New Zealand the species spread seemed low (Tindall et al. 2007). But in other countries, the Common Myna appeared to be spreading fast. For example, in the Middle East, particularly in Israel, the extremely short time-lag of just a few years from first occurrence to the rapid spread of the species was quite remarkable (Holzapfel et al. 2006).
2.17. Estimate the overall potential for spread in relevant biogeographical regions in foreseeable climate change conditions	likely	high	Common Mynas are originally from tropical and subtropical climates hence severe winters may be the most limiting factor. Therefore, further warming of the climate due to climate change, may benefit the species in colonising new areas, i.e. by the 2070s, climate change is predicted to increase suitability in the 'already-suitable' region of Europe and also expand the suitable region northwards (see Annex IV).

MAGNITUDE OF IMPACT			
Important instructions: • Questions 2.18-2.22 relate to environmental impact, 2.23-2.25 to impacts on ecosystem services, 2.26-2.30 to economic impact, 2.31-2.32 to social and human health impact, and 2.33-2.36 to other impacts. These impacts can be interlinked, for example a disease may cause impacts on biodiversity and/or ecosystem functioning that leads to impacts on ecosystem services and finally economic impacts. In such cases the assessor should try to note the different impacts where most appropriate, cross-referencing between questions when needed. • Each set of questions above starts with the impact elsewhere in the world, then considers impacts in Europe separating known impacts to date (i.e. past and current impacts) from potential future impacts (including foreseeable climate change). • Assessors are requested to use and cite original, primary references as far as possible.			
QUESTION	**RESPONSE**	**CONFIDENCE**	**COMMENTS**
Biodiversity and ecosystem impacts			
2.18. How important is impact of the organism on biodiversity at all levels of organisation caused by the organism in its non-native range excluding the Union?	major	high	The impact on biodiversity and related ecosystem services is multifaceted: the Common Myna is known to have contributed to the decline of native bird species through predation of eggs and nestlings and competition dynamics (i.e. for feeding locations, roosting sites and nesting sites), along with the transmission of parasites and diseases (Lever 1994, Saavedra et al. 2015, Peacock et al. 2007, Grarock et al. 2012). As reported below in detail, *A. tristis* contributed to spread invasive alien plants, hence acting as a major driver of habitat change. In general, despite some notable exception (see below), the documented impact of the Common Myna on native biodiversity is not backed up by quantitative studies. Empirical evidence of the impact of introduced species can be difficult to obtain (Grarock et al. 2012), hence most descriptions focusing on negative interactions of alien birds with native species are only anecdotal (Strubbe et al. 2011, Evan et al. 2016), like in the case of the Common Myna in Australia (Grarock et al. 2012, Haythorpe et al. 2012), South Africa (Peacock et al. 2007) and Israel (Holzapfel et al. 2006). However, there are some notable exceptions. An

			example is the work carried out in Australia, suggesting that the Common Myna had a negative impact on the long-term abundance of some cavity-nesting bird species and some small bird species (Grarock et al. 2012, 2013). Another exception is a New Zealand study, which demonstrated that the Common Myna can influence the numbers of the various species of birds (Tindall et al. 2007). Otherwise there are authors who stressed the lack of scientific evidence of the threat posed by the Common Myna, particularly in heavily urbanised environments (Lowe et al. 2011). **Predation**: In Tahiti for example, the Common Myna is involved in the predation and decline of Tahiti flycatcher (*Pomarea nigra*) (Blanvillain et al., 2003). This is one of the first evidence which documents the potentially direct negative impact on numerous endemic bird species all around the Pacific islands. Similarly, in Ascension island, the Common Myna extensively predates native Sooty Tern (*Onychoprion fuscatus*) colonies (Varnham 2006; Hughes et al. 2017), and in Hawaii represents a main cause of mortality of wedge-tailed shearwater (*Puffinus pacificus*) eggs (Byrd et al. 1984). Hughes et al. (2017) note that *A. tristis* is major predator of eggs of Sooty Tern on Ascension island, but also cause egg losses by puncturing and consuming eggs, puncturing eggs without consumption or by displacing incubating birds that then desert viable eggs. In the Seychelles, it was observed predating on the eggs and chicks of both the Seychelles black paradise flycatcher (*Terpsiphone corvina*) and the Magpie Robin (*Copsychus sechellarum*) (Feare 2010). In Israel, the predation of the House Sparrow (*Passer domesticus*) chicks was documented (Holzapfel et al. 2006). **Competition**: With a few exceptions (see Lowe at al. 2011), the Common Myna seems to have a significant competitive impact on native bird species, particularly on islands. According to

			GISD (2017) the species was implicated in the demise of the lowland populations of the 'Vulnerable (VU)' Rarotonga starling (*Aplonis cinerascens*) in the Cook Islands, and can displace breeding pairs of the Endangered (EN) Mauritius parakeet (*Psittacula eques*) in Mauritius. In the Seychelles, Common Mynas compete for food and nesting sites with the endangered Magpie Robin (*Copsychus sechellarum*) (Feare et al, 2016), and is considered a threat to the endangered white-eye (*Zosterops modestus*) in the same area (Birdlife, 2016). Aggressive behaviour towards Syrian Woodpecker (*Dendrocopos syriacus)* has also been noted in the vicinity of nesting holes (Holzapfel et al. 2006). Similar behaviour usually associated with defence of the nest-site between introduced mynas and native birds occurred in Australia (Pell and Tidemann 1997a, Haythorpe et al. 2012). Pell and Tidemann (1997b) provide some evidence regarding the impact of the Common Myna (along with the starling *Sturnus vulgaris*) on two native parrots in Australia as a result of competition for nesting sites. A study carried out in Australia (Grarock et al. 2013) confirmed the negative impact of *A. tristis* on native birds abundance, through cavity-nesting domination. Also in Israel a study focusing on the interaction of Common Myna with other cavity-nesting birds during the breeding season, evidenced continued aggressive behaviours toward both native and alien bird species (Orchan et al. 2012). In South Africa interspecific aggression between Common Mynas and indigenous birds was occasionally witnessed in urban environments, but potential displacement of indigenous species seemed limited to the local scale (Peacock et al. 2007). **Transmission of parasites and diseases:** In its native range the myna carries a high prevalence and diversity of haemosporidian parasites, including some of the most widespread and potentially invasive *Plasmodium* lineages (Feare and Craig 1998, Clark et al. 2015). Thus

			Common Mynas may cause infections which might be particularly harmful for the native avifauna, while they themselves remain largely unaffected. Also Ishtiaq et al. (2006) pointed out some evidence that Common Mynas may have carried haematozoan parasites from native to introduced locations, and also that introduced populations may have become infected with novel parasite lineages, but it seemed difficult to differentiate between parasites that are native and introduced. The results of a recent study (Clark et al. 2015) show that in Australia introduced mynas may benefit through escape from *Haemoproteus* spp. while acting as important reservoirs for *Plasmodium* spp., some of which are known exotic lineages. Such host-pathogen interactions may raise concerns because in general it is evident that while invaders may encounter reduced pathogen abundance and diversity, they may carry novel pathogens that spill over to local/native competitors, and as such can influence the invasion success. Mynas are also among the birds with a high tolerance for human-altered habitats, and humans are known to become infected fatally from H5N1 virus (FAO 2007). **Spread of invasive alien plants**: Common Mynas have been implicated in the dispersal of invasive alien plants, e.g. *Cinnamomum zeylanicum* in the Seychelles (Fleischmann 1997), and *Lantana camara* in Hawaii (Lever 1994). Thus, by dispersing seeds of alien plants they may indirectly contribute to facilitate major habitat changes.
2.19. How important is the impact of the organism on biodiversity at all levels of organisation (e.g. decline in native species, changes in native species communities, hybridisation) currently in the different biogeographical regions or marine sub-regions where the species has established in Europe (include any past impact in your response)?	Minor	high	In Europe, the current adverse effects of Common Mynas on native biodiversity and relevant ecosystem services is not well documented, and similarly to what reported in other countries like Australia (Haythorpe et al. 2012), South Africa (Peacock et al. 2007) and Israel (Holzapfel et al. 2006), most descriptions are anecdotal. For example, Saavedra et al. (2015) observed several instances of aggressions of the related crested mynas (*A. cristatellus*) foraging in urban environments towards a variety of native species, from

			smaller–sized (barn swallow *Hirundo rustica*, white wagtail *Motacilla alba*, house sparrow *Passer domesticus*) to similarly–sized (black starling *Sturnus unicolor*, blackbird *Turdus merula*) and much larger–sized species (Eurasian kestrel *Falco tinnunculus*, yellow–legged gull *Larus michahellis*). As pointed out by Saavedra et al. (2015) introduced mynas in urbanized continental environments may have little impact on native communities, compared to the negative effect identified on islands (although urban habitats are becoming increasingly important also from a conservation point of view). This is consistent with the findings of recent works in Australia showing that Common Mynas have little competitive impact on native bird species in urban and suburban habitats (Lowe at al. 2011, Haythorpe et al., 2014). However, Common Mynas have the potential to spread throughout rural environments where their impact may extend to a wider array of native species and agriculture (see Pell and Tidemann, 1997a). There is no specific information available on changes of ecosystem functioning in Europe so far, although the impact on native species may lead to changes in some ecosystem functions (e.g. changes in trophic chains).
2.20. How important is the impact of the organism on biodiversity at all levels of organisation likely to be in the future in the different biogeographical regions or marine sub-regions where the species can establish in Europe?	moderate	low	In the Iberian Peninsula a continued growth and spread of the species is expected in the absence of management action (Saavedra et al. 2015). Therefore it is likely that the impact of the species on biodiversity and related ecosystem services in the Mediterranean region will increase accordingly. As a side note, athough outisde the risk assessment area, further introductions leading to some relevant impact are also possible in the Macaronesian region, where some individuals were recorded even after the successful eradication of the populations once established in the Canary islands. There is no specific information available on changes of ecosystem functioning in Europe so far, although the reported impact on native species indicates changes in some

			ecosystem functions (e.g. changes in trophic chains). With the extension of the suitable range in the future it is likely that this impact will increase. But it is not possible to assess the actual extent of this impact in the future.
2.21. How important is decline in conservation value with regard to European and national nature conservation legislation caused by the organism currently in Europe?	minor	low	In Europe, the adverse effects of *Acridotheres tristis* on native biodiversity is not well documented, and similarly to what reported in other countries, like Australia (Haythorpe et al. 2012), South Africa (Peacock et al. 2007) and Israel (Holzapfel et al. 2006), most descriptions are only anecdotal. According to the result of a global assessment of alien bird impacts on the basis of the EICAT system (Environmental Impact Classification for Alien Taxa), the highest documented impact of *Acridotheres tristis* is categorised as moderate (MO) (Evans et al. 2016). In Europe, despite the occurrence of species potentially affected, quantitative data on the actual extent of the impact of *Acridotheres tristis* in the conservation status are not available. Saavedra et al. (2015) report some native species affected by Crested Mynas (not *A. tristis*) but all mentioned species are of least concern and not included in the Annex I of the Birds Directive (see point 2.12 above).
2.22. How important is decline in conservation value with regard to European and national nature conservation legislation caused by the organism likely to be in the future in Europe?	moderate	low	In Europe, the adverse effects of *Acridotheres tristis* on native biodiversity is not well documented, and similarly to what reported in other countries like Australia (Haythorpe et al. 2012), South Africa (Peacock et al. 2007) and Israel (Holzapfel et al. 2006), most descriptions are only anecdotal. In Europe, despite the occurrence of species potentially affected quantitative data on the actual extent of the impact are not available. Saavedra et al. (2015) report some native species affected by Crested Mynas (not *Acridotheres tristis*) but all mentioned species are of least concern and not included in the Bird directive.
Ecosystem Services impacts			
2.23 How important is the impact of the organism on	moderate	low	No specific studies on the impact on ecosystem services are

provisioning, regulating, and cultural services in its non-native range excluding the Union?			available, but on the basis of evidence collected in Europe and beyond, and taking into account the study by Vilà et al. (2009) it can be assumed that the species may affect supporting services (such as community changes), provisioning services (e.g. by threatening endangered native species, or resulting in losses in the agricultural sector for affecting the productivity of agroecosystems), regulating services (by transmitting infections to native fauna) and cultural (e.g. through a generic change in recreational use). See also point 2.26 below.
2.24. How important is the impact of the organism on provisioning, regulating, and cultural services currently in the different biogeographical regions or marine sub-regions where the species has established in Europe (include any past impact in your response)?	N/A		No information has been found on the issue
2.25. How important is the impact of the organism on provisioning, regulating, and cultural services likely to be in the different biogeographical regions or marine sub-regions where the species can establish in Europe in the future?	N/A		No information has been found on the issue
Economic impacts			
2.26. How great is the overall economic cost caused by the organism within its current area of distribution, including both costs of damage and the cost of current management?	major	high	*Acridotheres tristis* is considered a potential agricultural pest (Saavedra et al. 2015, Holzapfel et al. 2006), particularly when insects are scarce, because fruits and seeds may become an important component of its diet (see Peacock et al. 2007). A number of fruit crops are likely to be affected, e.g. grapes, figs, apricots, papaya, dates, apple, pear, strawberries, gooseberries, tomato, along with cereal crops such as maize, wheat and rice (Lever 1994, GISD 2017). The species is also known to be a nuisance species at urban roost sites, due to the communal roosting behaviour (Sarangi et al. 2014), associated to disruptive noise disturbance and droppings, along with other associated mess, including to infrastructures (Brochier et al. 2010, Holzapfel et al. 2006, Saavedra 2009). As reported by Peacock et al. (2007) the diet of *A. tristis*

			consists of insects and other invertebrates, including beneficial insects (also in some of the areas where it was originally introduced to control pest insects, Feare and Craig 1998). This may affect the productivity of agroecosystems. *Acridotheres tristis* may contribute to the spread of harmful diseases and parasites that affect people and farm stock (Brochier et al. 2010, Saavedra 2009), and may even represent a risk for aviation in relation to bird-strikes (CABI 2014, Australian Transport Safety Bureau 2012). Figures on costs associated to the economic impacts mentioned above are rare and scattered. The risk assessment of the species in Queensland (Australia) reports that the annual value of property damage is estimated at least $AUS 50 million (Markula et al. 2016). Also costs on management are rarely reported. An exception is the recent paper on the eradication of *Acridotheres tristis* in Denis island (143 ha, in the Seychelles) according to which the overall cost was estimated to be $US 156 950, of which $US 27 600 for fees and transport, including for the training and for the hunter, $US 9000 for equipment, $US 16 800 for project management. (Feare et al. 2017). In Mangaia Island (5180 ha, in the Cook islands) it was estimated that the costs to achieve eradication with appropriate levels of monitoring would be about $NZ 100 000 (Parkes 2006).
2.27 How great is the economic cost of damage*of the organism currently in the Union (include any past costs in your response)? *i.e. excluding costs of management	minor	low	No information has been found on the issue. There are no specific economic impacts currently reported in Europe. Therefore figures on the relevant costs are not available.
2.28. How great is the economic cost of damage* the organism likely to be in the future in the Union? *i.e. excluding costs of management	moderate	low	In the Iberian Peninsula a continued growth and spread of the species is expected in the absence of management action (Saavedra et al. 2015). Therefore it is likely that the impact of the species in the Mediterranean region will increase accordingly.
2.29. How great are the economic costs associated with	minor	low	No information has been found on the issue. The species has

managing this organism currently in the Union (include any past costs in your response)?			been subject to eradication and control programmes in Spain, specifically the Balearic and Canary island (Saavedra et al. 2015). However figures on the relevant costs are not available.
2.30. How great are the economic costs associated with managing this organism likely to be in the future in the Union?	moderate	low	In the light of the possible increase of the areas suitable for the species in the EU in the future, also the management costs may raise compared to what estimated for point 2.20 above.
Social and human health impacts			
2.31. How important is social, human health or other impact (not directly included in any earlier categories) caused by the organism for the Union and for third countries, if relevant (e.g. with similar eco-climatic conditions).	moderate	medium	*Acridotheres tristis* may represent a threat to human well-being mostly due to its impact on public health and agricultural crops (GISD 2017, Peacock et al. 2007). In fact *Acridotheres tristis* is known to spread parasites and diseases that may pose a human health risk (Saavedra 2010), i.e. they carry bird mites such as *Ornithonyssus bursa* and *Dermanyssus gallinae* that may infect humans, along with owl flies, biting lice, *Oxyspirrura* thread worms and round worms. They can also cause dermatitis, asthma, severe irritation and rashes, and their droppings can spread Psittacosis, Ornithosis, Salmonellosis and arboviruses (GISD 2017). Additionally, mynas have been known to become infected fatally from H5N1 (FAO 2007). Communal roost sites placed in proximity to residential areas can be noisy, may cause accumulation of droppings, and have unpleasant odours (GISD 2017, Peacock et al. 2007). Additionally, nests may be built in spoutings, chimneys and other parts of buildings and houses, and thus damage infrastructures (Stoner 1923, Saavedra 2009). In the Hawaii specific measures were implemented to mitigate the disturbance to residents and tourists (Kurdila 1995) but eco-climatic conditions are different from Europe, hence it is not possible to establish whether this will be a problem in the EU. Mynas are also known to steal food from houses, restaurants and gardens, and to scavenge rubbish dumps, farmlands and roads for roadkill, thus leading to generalised

			hygiene problems and public health concern (GISD 2017). Also for this type of impact information is mostly anecdotal and it is not clear whether the situation in the EU is comparable. It may be worth mentioning here some results of some surveys made in areas very different from the EU, even though characterised by different eco-climatic conditions, because they are the only one giving an idea of how the species is perceived by the general public. For example, a dedicated survey aimed at assessing the perceived social impact was made in Wollongong (Australia) by the Water and Wildlife Ecology Research Group (2004), showing that a main impact attributed to mynas on property was the displacement of native birds/wildlife, followed by nesting in roof space and bird droppings in unwanted areas. A similar survey made in the Fiji islands (Prasad and Christi 2014) confirmed that the species is considered a pest because of stolen food from kitchens, damage of crops and fruits, noise pollution, pollution with droppings on drinking water, buildings and clothes on washing lines (but some benefits were also highlighted). Finally, there have been reports of *Acridotheres tristis* attacking people (Haythorpe et al. 2012, Markula et al. 2016), along with domestic dogs (*Canis familiaris*) and cats (*Felis catus*), (Haythorpe et al. 2012), although the extent of the problem, which is not documented, is probably negligible.
2.32. How important is social, human health or other impact (not directly included in any earlier categories) caused by the organism in the future for the Union.	moderate	low	Future impacts (as described in 2.23) will increase with increasing range and numbers of the species.
Other impacts			
2.33. How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	moderate	medium	As with other bird species which live in close proximity to humans, *Acridotheres tristis* is a potential vector for human pathogens and diseases (see 3.31).
2.34. How important might other impacts not already covered	NA		

by previous questions be resulting from introduction of the organism? (specify in the comment box)			
2.35. How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Europe?	major	low	It is unlikely that predation or transmission of parasites and pathogens from existing species in Europe will prevent the impact of *Acridotheres tristis*.
2.36. Indicate any parts of Europe where any of the above impacts are particularly likely to occur (provide as much detail as possible).	[insert text + attach map if possible]	low	The above impacts are particularly likely to occur in any of the countries where the species may become established.

ADDITIONAL QUESTIONS - CLIMATE CHANGE			
3.1. What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	[increase of temperatures, particularly in winter season]	high	
3.2. What is the likely timeframe for such changes?	50 years	high	
3.3. What aspects of the risk assessment are most likely to change as a result of climate change?	[distribution range, likelihood of establishment]	high	Changes in winter temperature may affect winter survival and rates of reproduction as well as survival of offspring and lead to an increase of population size and distribution range.
ADDITIONAL QUESTIONS - RESEARCH			
4.1. If there is any research that would significantly strengthen confidence in the risk assessment please summarise this here.	[detailed data on pathways and impact in Europe]	very high	There is a general lack of details on the number of birds that were released or did escape in Europe (Holzapfel et al. 2006). Surveillance and monitoring activities should be established to aim at the acquisition of data on the number of individuals released/escaped and the frequency of such introduction events. Also, understanding the population dynamics of the species would be key to undertaking a successful control program (Grarock et al. 2014). Research projects and monitoring activities aimed at collecting reliable data about the environmental and socio-economic impact are urgently needed. Birders should be encouraged to keep notes on any such interspecific interactions and the introduction and spread of alien species in general (Holzapfel et al. 2006, Peacock et al. 2007).

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ANNEX I - Scoring of Likelihoods of Events

(taken from UK Non-native Organism Risk Assessment Scheme User Manual, Version 3.3, 28.02.2005)

Score	**Description**	**Frequency**
Very unlikely	This sort of event is theoretically possible, but is never known to have occurred and is not expected to occur	1 in 10,000 years
Unlikely	This sort of event has not occurred anywhere in living memory	1 in 1,000 years
Possible	This sort of event has occurred somewhere at least once in recent years, but not locally	1 in 100 years
Likely	This sort of event has happened on several occasions elsewhere, or on at least one occasion locally in recent years	1 in 10 years
Very likely	This sort of event happens continually and would be expected to occur	Once a year

ANNEX II - Scoring of Magnitude of Impacts

(modified from UK Non-native Organism Risk Assessment Scheme User Manual, Version 3.3, 28.02.2005)

Score	**Biodiversity and ecosystem impact**	**Ecosystem Services impact**	**Economic impact (Monetary loss and response costs per year)**	**Social and human health impact**
	Question 2.18-22	*Question 2.23-25*	*Question 2.26-30*	*Question 2.31-32*
Minimal	Local, short-term population loss, no significant ecosystem effect	No services affected[1]	Up to 10,000 Euro	No social disruption. Local, mild, short-term reversible effects to individuals.
Minor	Some ecosystem impact, reversible changes, localised	Local and temporary, reversible effects to one or few services	10,000-100,000 Euro	Significant concern expressed at local level. Mild short-term reversible effects to identifiable groups, localised.
Moderate	Measureable long-term damage to populations and ecosystem, but little spread, no extinction	Measureable, temporary, local and reversible effects on one or several services	100,000-1,000,000 Euro	Temporary changes to normal activities at local level. Minor irreversible effects and/or larger numbers covered by reversible effects, localised.
Major	Long-term irreversible ecosystem change, spreading beyond local area	Local and irreversible or widespread and reversible effects on one / several services	1,000,000-10,000,000 Euro	Some permanent change of activity locally, concern expressed over wider area. Significant irreversible effects locally or reversible effects over large area.
Massive	Widespread, long-term population loss or extinction, affecting several species with serious ecosystem effects	Widespread and irreversible effects on one / several services	Above 10,000,000 Euro	Long-term social change, significant loss of employment, migration from affected area. Widespread, severe, long-term, irreversible health effects.

[1] Not to be confused with „no impact".

ANNEX III - Scoring of Confidence Levels

(modified from Bacher et al. 2017)

Confidence level	**Description**
Low	There is no direct observational evidence to support the assessment, e.g. only inferred data have been used as supporting evidence *and/or* Impacts are recorded at a spatial scale which is unlikely to be relevant to the assessment area *and/or* Evidence is poor and difficult to interpret, e.g. because it is strongly ambiguous *and/or* The information sources are considered to be of low quality or contain information that is unreliable.
Medium	There is some direct observational evidence to support the assessment, but some information is inferred *and/or* Impacts are recorded at a small spatial scale, but rescaling of the data to relevant scales of the assessment area is considered reliable, or to embrace little uncertainty *and/or* The interpretation of the data is to some extent ambiguous or contradictory.
High	There is direct relevant observational evidence to support the assessment (including causality) *and* Impacts are recorded at a comparable scale *and/or* There are reliable/good quality data sources on impacts of the taxa *and* The interpretation of data/information is straightforward *and/or* Data/information are not controversial or contradictory.
Very high	There is direct relevant observational evidence to support the assessment (including causality) from the risk assessment area *and* Impacts are recorded at a comparable scale *and* There are reliable/good quality data sources on impacts of the taxa *and* The interpretation of data/information is straightforward *and* Data/information are not controversial or contradictory.

ANNEX IV - Species Distribution Model

Projection of climatic suitability for *Acridotheres tristis* establishment

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26 June 2017

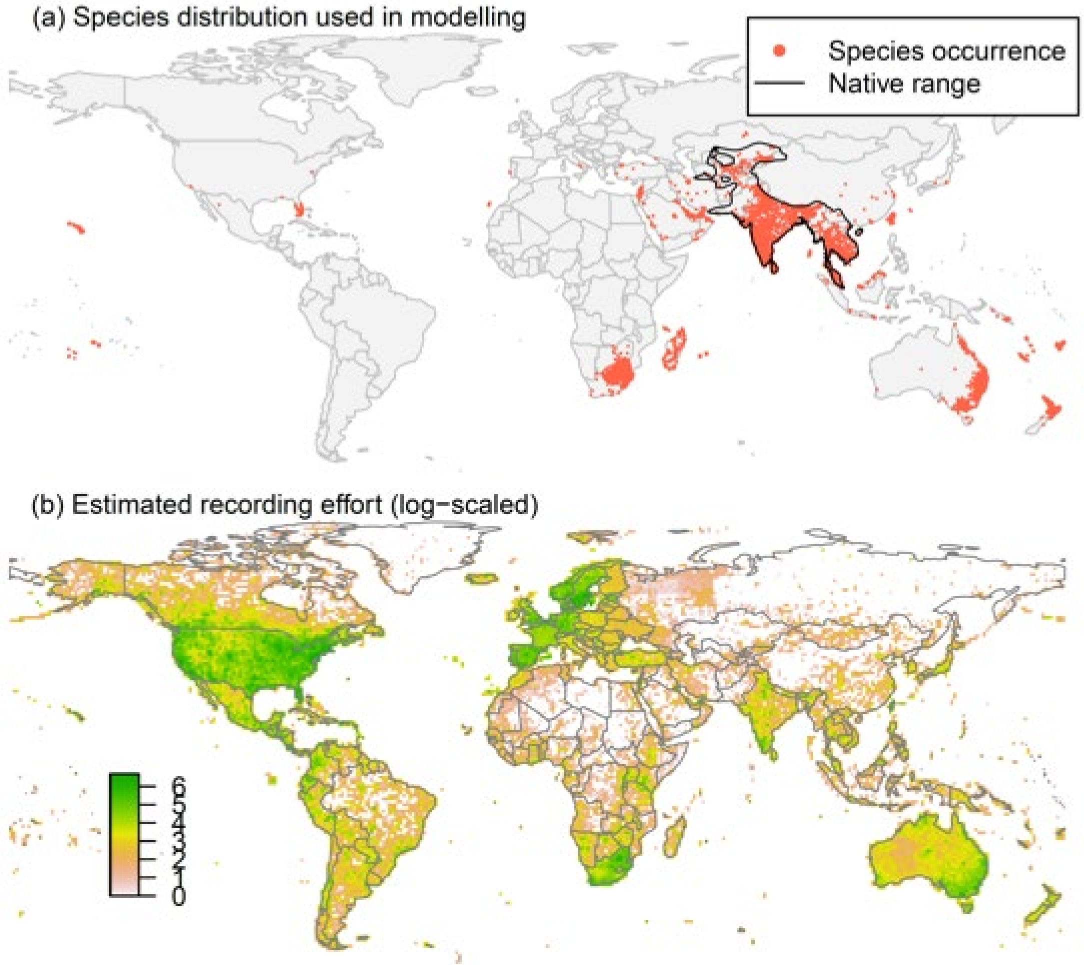
Aim

To project the suitability for potential establishment of *Acridotheres tristis* in Europe, under current and predicted future climatic conditions.

Data for modelling

Species occurrence data were obtained from the Global Biodiversity Information Facility (GBIF) supplemented with a small number of additional records from the risk assessment team. We scrutinised occurrence records from regions where the species is not known to be established and removed any dubious records (e.g. fossils, captive records) or where the georeferencing was too imprecise (e.g. records referenced to a country or island centroid) or outside of the coverage of the predictor layers (e.g. small island or coastal occurrences). The remaining records were gridded at a 0.25 x 0.25 degree resolution for modelling, yielding 4845 grid cells with occurrence (Figure 1a). As a proxy for recording effort, the density of Aves records held by GBIF was also compiled on the same grid (Figure 1b).

Figure 1. (a) Occurrence records obtained for *Acridotheres tristis* and used in the modelling. The native range polygon was obtained from the IUCN (BirdLife International, 2017). (b) The recording density of Aves on GBIF, which was used as a proxy for recording effort.



Climate data were selected from the 'Bioclim' variables contained within the WorldClim database (Hijmans *et al.*, 2005) originally at 5 arcminute resolution (0.083 x 0.083 degrees of longitude/latitude) and aggregated to a 0.25 x 0.25 degree grid for use in the model. Based on the biology of the focal species (CABI, 2014), the following climate variables were used in the modelling:

- Mean minimum temperature of the coldest month (Bio6 °C) reflecting exposure to winter cold and frost, which may be a trigger for hibernation behaviour.
- Mean temperature of the warmest quarter (Bio10 °C) reflecting the thermal regime of the active season.
- Climatic moisture index (CMI, ratio of mean annual precipitation to potential evapotranspiration, log+1 transformed) reflecting moisture regime. For its calculation, monthly potential evapotranspirations were estimated from the WorldClim monthly temperature data and solar radiation using the simple method of Zomer *et al.* (2008) which is based on the Hargreaves evapotranspiration equation (Hargreaves, 1994).
- Precipitation seasonality (Bio15, coefficient of variation for monthly precipitations, log+1 transformed), which was considered potentially important for *A. tristis* by the risk assessment expert working group.

To estimate the effect of climate change on the potential distribution, equivalent modelled future climate conditions for the 2070s under the Representative Concentration Pathways (RCP) 4.5 and 8.5 were also obtained. There represent medium and high emissions scenarios, respectively. The above variables were obtained as averages of outputs of eight Global Climate Models (BCC-CSM1-1, CCSM4, GISS-E2-R, HadGEM2-AO, IPSL-CM5A-LR, MIROC-ESM, MRI-CGCM3, NorESM1-M), downscaled and calibrated against the WorldClim baseline (see http://www.worldclim.org/cmip5_5m).
The following habitat layers were also used:

- Tree cover was estimated from the MODerate-resolution Imaging Spectroradiometer (MODIS) satellite continuous tree cover raster product, produced by the Global Land Cover Facility (http://glcf.umd.edu/data/vcf/). The raw product contains the percentage cover by trees in each 0.002083 x 0.002083 degree grid cell. We aggregated this to the mean cover in our 0.25 x 0.25 degree grid cells.
- Human influence index as many non-native invasive species associate with anthropogenically disturbed habitats. We used the Global Human Influence Index Dataset of the Last of the Wild Project (Wildlife Conservation Society - WCS & Center for International Earth Science Information Network - CIESIN - Columbia University, 2005), which is developed from nine global data layers covering human population pressure (population density), human land use and infrastructure (built-up areas, nighttime lights, land use/land cover) and human access (coastlines, roads, railroads, navigable rivers). The index ranges between 0 and 1 and was ln+1 transformed for the modelling to improve normality.

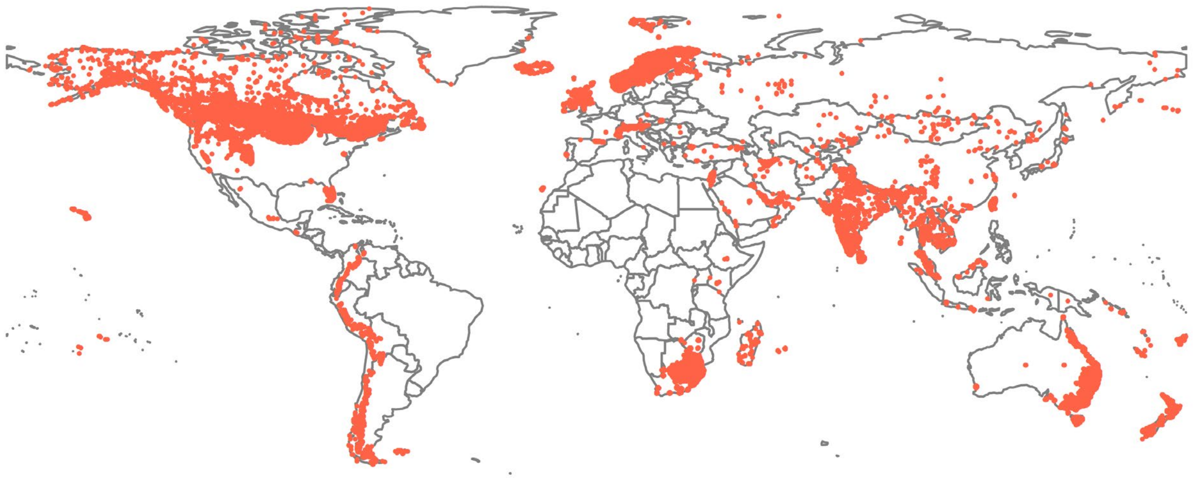
Species distribution model
A presence-background (presence-only) ensemble modelling strategy was employed using the BIOMOD2 R package v3.3-7 (Thuiller *et al.*, 2014, Thuiller *et al.*, 2009). These models contrast the environment at the species' occurrence locations against a random sample of the global background environmental conditions (often termed 'pseudo-absences') in order to characterise and project suitability for occurrence. This approach has been developed for distributions that are in equilibrium with the environment. Because invasive species' distributions are not at equilibrium and subject to dispersal constraints at a global scale, we took care to minimise the inclusion of locations suitable for the species but where it has not been able to disperse to. Therefore the background sampling region included:

- The area accessible by native *A. tristis* populations, in which the species is likely to have had sufficient time to disperse to all locations. Based on a known maximum dispersal distance (Oschadleus, 2000), the accessible region was defined as a 400 km buffer around the IUCN's native range polygon (Hammerson *et al.*, 2007); AND

- A 30 km buffer around the non-native occurrences, encompassing regions likely to have had high propagule pressure for introduction by humans and/or dispersal of the species; AND
- Regions where we have an *a priori* expectation of high unsuitability for the species so that absence is considered to be irrespective of dispersal constraints (see Figure 2). As we expected low temperature to be the key limiting factor for Europe, the following rules were applied to define a region expected to be highly unsuitable for *A. tristis* at the spatial scale of the model:
    - Mean temperature of the warmest quarter (Bio10) < 14 °C. Only 1.1 % of occurrence grid cells were colder than this.
    - Mean minimum temperature of the coldest month (Bio6) < -14 °C. Only 1.1% of occurrence grid cells were colder than this.

Within this background region, 10 samples of 5000 randomly sampled grid cells were obtained, weighting the sampling by recording effort (Figure 2).

Figure 2. Randomly selected background grid cells used in the modelling of *Acridotheres tristis*, mapped as red points. Points are sampled from the native range, a small buffer around non-native occurrences and from areas expected to be highly unsuitable for the species (grey background region), and weighted by a proxy for recording effort.



Each dataset (i.e. combination of the presences and the individual background samples) was randomly split into 80% for model training and 20% for model evaluation. With each training dataset, ten statistical algorithms were fitted with the default BIOMOD2 settings and rescaled using logistic regression, except where specified below:

- Generalised linear model (GLM)
- Generalised boosting model (GBM)
- Generalised additive model (GAM) with a maximum of four degrees of freedom per smoothing spline.

- Classification tree algorithm (CTA)
- Artificial neural network (ANN)
- Flexible discriminant analysis (FDA)
- Multivariate adaptive regression splines (MARS)
- Random forest (RF)
- Maxent
- Maximum entropy multinomial logistic regression (MEMLR)

Since the background sample was much larger than the number of occurrences, prevalence fitting weights were applied to give equal overall importance to the occurrences and the background. Normalised variable importance was assessed and variable response functions were produced using BIOMOD2's default procedure. Model predictive performance was assessed by calculating the Area Under the Receiver-Operator Curve (AUC) for model predictions on the evaluation data, that were reserved from model fitting. AUC is the probability that a randomly selected presence has a higher model-predicted suitability than a randomly selected absence.

An ensemble model was created by first rejecting poorly performing algorithms with relatively extreme low AUC values and then averaging the predictions of the remaining algorithms, weighted by their AUC. To identify poorly performing algorithms, AUC values were converted into modified z-scores based on their difference to the median and the median absolute deviation across all algorithms (Iglewicz & Hoaglin, 1993). Algorithms with $z < -2$ were rejected. In this way, ensemble projections were made for each dataset and then averaged to give an overall suitability, as well as its standard deviation. The projections were then classified into suitable and unsuitable regions using the 'minROCdist' method.

We also produced limiting factor maps for Europe following Elith *et al.* (2010). For this, projections were made separately with each individual variable fixed at a near-optimal value. These were chosen as the median values at the occurrence grid cells. Then, the most strongly limiting factors were identified as the one resulting in the highest increase in suitability in each grid cell.

Results

The ensemble model suggested that suitability for *A. tristis* was most strongly determined by temperature, with strong effects of minimum temperature of the coldest month and mean temperature of the warmest quarter (Table 1, Figure 3). In both cases, the model fitted strong low temperature limitation. There were also weaker preferences for moderately moist and human-impacted locations, seasonal precipitation regimes and low tree cover (Table 1, Figure 3)

Global projection of the model in current climatic conditions indicates that the native and known invaded records generally fell within regions predicted to have high suitability (Figure 4). The model predicts potential for further expansion of the non-native range of the species in tropical and subtropical regions of the northern and southern hemispheres (Figure 4). In Europe, the model suggested establishment may be possible through southwest Iberia and around the northern Mediterranean coast, especially towards the east (Figure 5). Outside of these regions, low summer temperatures were identified as the main limiting factor (Figure 6).

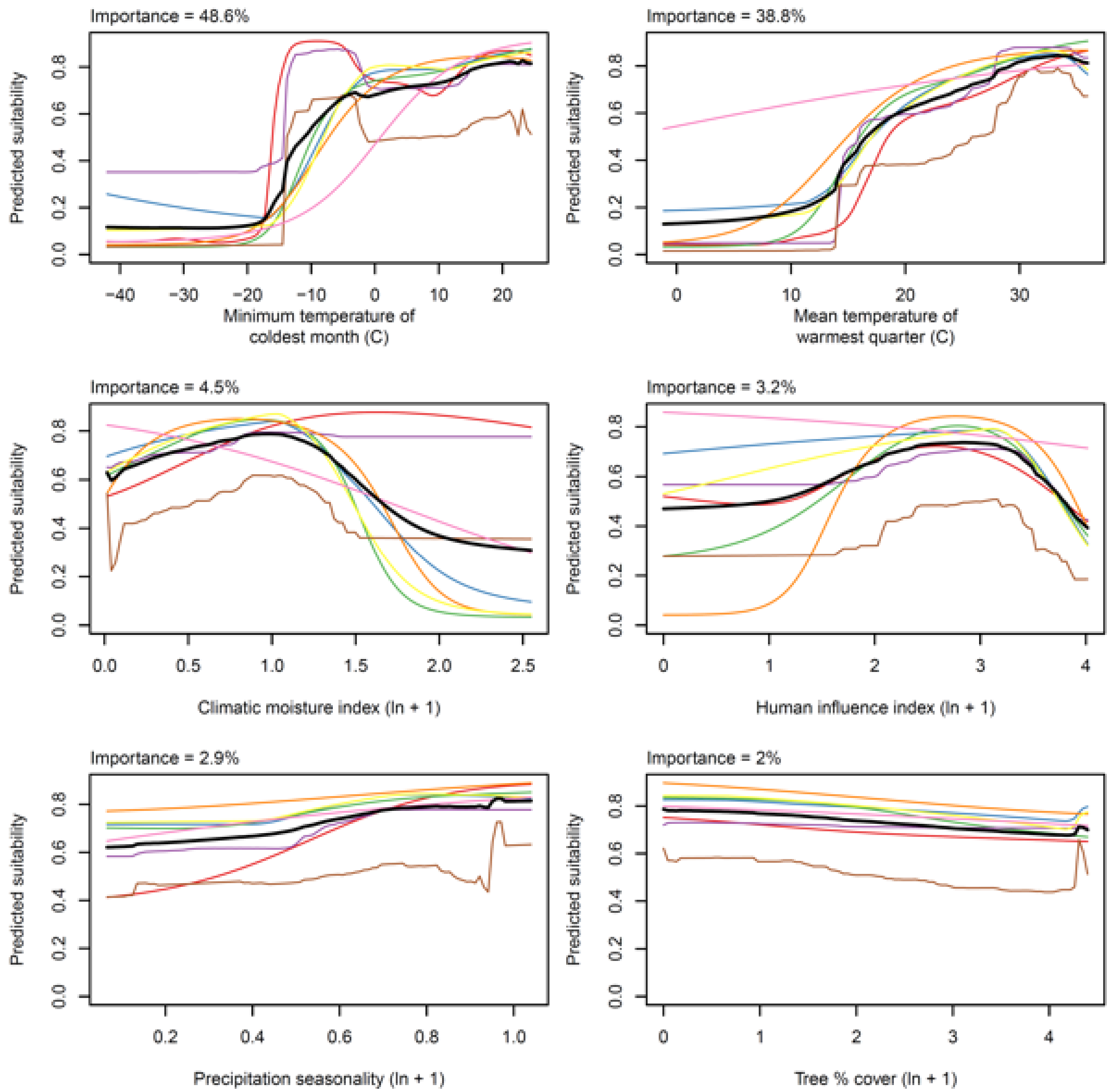
By the 2070s, climate change is predicted to increase suitability in the 'already-suitable' region of Europe and also expand the suitable region northwards (Figures 7 and 8). In the more extreme climate change scenario (RCP8.5) the model even predicts suitability in coastal parts of Scandinavia and the Baltic region (Figure 8).

In terms of Biogeographical Regions (Bundesamt fur Naturschutz (BfN), 2003), those predicted to be most suitable for *A. tristis* establishment in the current climate are Mediterranean, Macaronesia, and Anatolian (Figure 9). European Union countries such as Cyprus, Portugal, Greece, Spain, Croatia, Italy and France are predicted to contain currently suitable climates (Figure 10). Climate change is predicted to increase suitability in all of these regions, as well as extending the suitable region into the Black Sea, Steppic, Pannonian and Atlantic regions (Figure 9) so that in the most extreme scenario some suitable climate might be found in all EU countries except Czech Republic (Figure 10). Czech Republic is predicted to remain fully unsuitable under climate change, while most other EU countries gain a little suitability in the most extreme climate scenario. This seems to be driven by two factors, warmer summers in western Europe, and warmer winters in far eastern and northern Europe, which cause pockets of very marginally suitable climate to appear in most countries. This doesn't happen in Czech, which possibly is because it is where these two factors cross over, i.e. there are still marginally too cold summers and winters even under climate change. However, certainty in the prediction is low.

Table 1. Summary of the cross-validation predictive performance (AUC) and variable importances of the fitted model algorithms and the ensemble (AUC-weighted average of the best performing algorithms). Results are the average from models fitted to ten different background samples of the data.

Algorithm	AUC	Used in the ensemble	Variable importance (%)					
			Minimum temperature of coldest month	Mean temperature of warmest quarter	Precipitation seasonality	Climatic moisture index	Human influence index	Tree cover
GBM	0.8651	yes	36	58	3	2	1	0
ANN	0.8646	yes	32	54	5	6	2	1
Maxent	0.8589	yes	32	56	1	4	4	2
GAM	0.8579	yes	49	35	3	6	4	3
FDA	0.8564	yes	49	38	4	4	4	2
MARS	0.8557	yes	46	38	3	6	4	3
GLM	0.8535	yes	54	29	2	5	6	4
MEMLR	0.8430	yes	92	2	2	3	1	1
CTA	0.8171	no	36	64	0	0	0	0
RF	0.7713	no	30	38	14	7	6	5
Ensemble	0.8597		49	39	3	4	3	2

Figure 3. Partial response plots from the fitted models, ordered from most to least important. Thin coloured lines show responses from the algorithms in the ensemble, while the thick black line is their ensemble. In each plot, other model variables are held at their median value in the training data. Some of the divergence among algorithms is because of their different treatment of interactions among variables.



Importance = 48.6%
Predicted suitability
0.0
0.2
0.4
0.6
0.8
−40
−30
−20
−10
0
10
20
Minimum temperature of coldest month (C)
Importance = 38.8%
0
10
20
30
Mean temperature of warmest quarter (C)
Importance = 4.5%
0.0
0.5
1.0
1.5
2.0
2.5
Climatic moisture index (ln + 1)
Importance = 3.2%
0
1
2
3
4
Human influence index (ln + 1)
Importance = 2.9%
0.2
0.4
0.6
0.8
1.0
Precipitation seasonality (ln + 1)
Importance = 2%
0
1
2
3
4
Tree % cover (ln + 1)

Figure 4. Projected global suitability for *Acridotheres tristis* establishment in the current climate. For visualisation, the projection has been aggregated to a 0.5 x 0.5 degree resolution, by taking the maximum suitability of constituent higher resolution grid cells. Values > 0.5 may be suitable for the species. White land areas have climatic conditions outside the range of the training data so were excluded from the projection. (b) Uncertainty in the ensemble projections, expressed as the among-algorithm standard deviation in predicted suitability, averaged across the ten datasets.

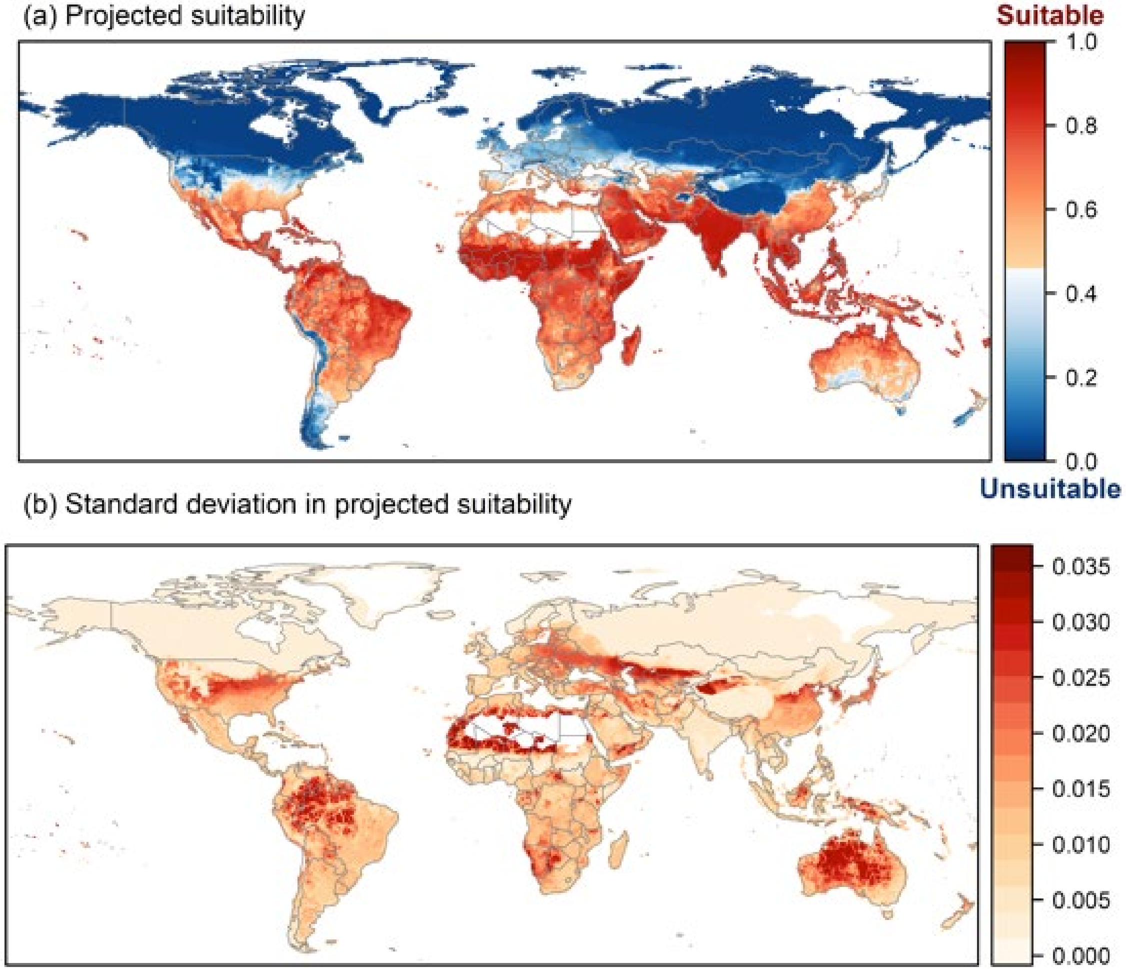


Figure 5. Projected current suitability for *Acridotheres tristis* establishment in Europe and the Mediterranean region. The white areas have climatic conditions outside the range of the training data so were excluded from the projection.

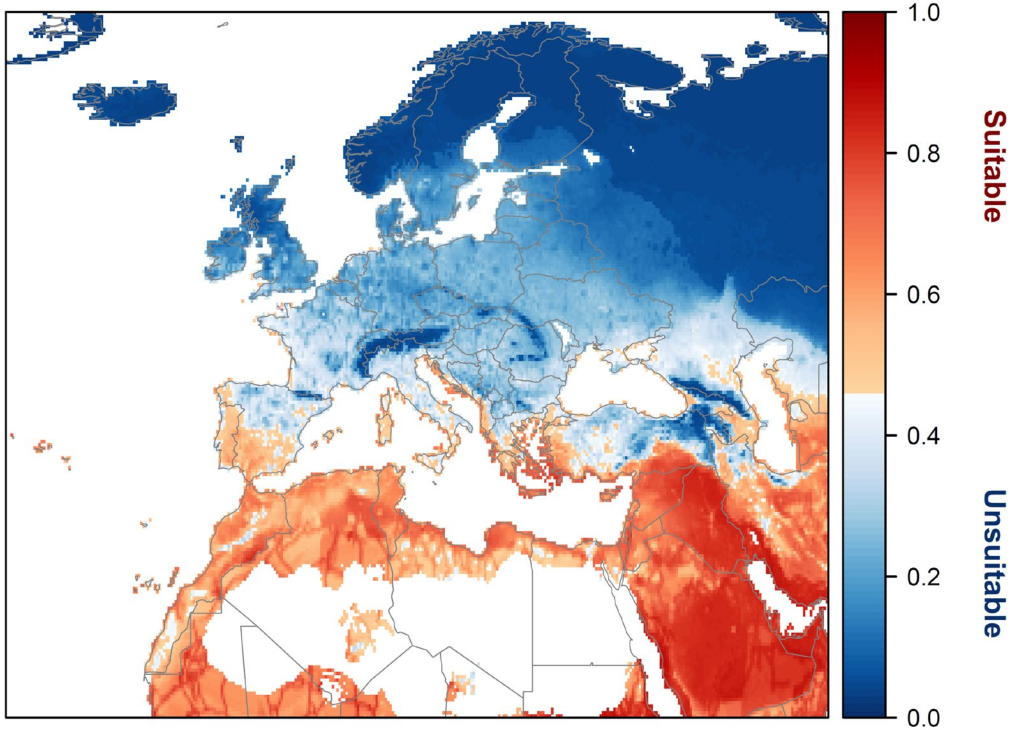


Figure 6. The most strongly limiting factor estimated by the model in Europe and the Mediterranean region in current climatic conditions.

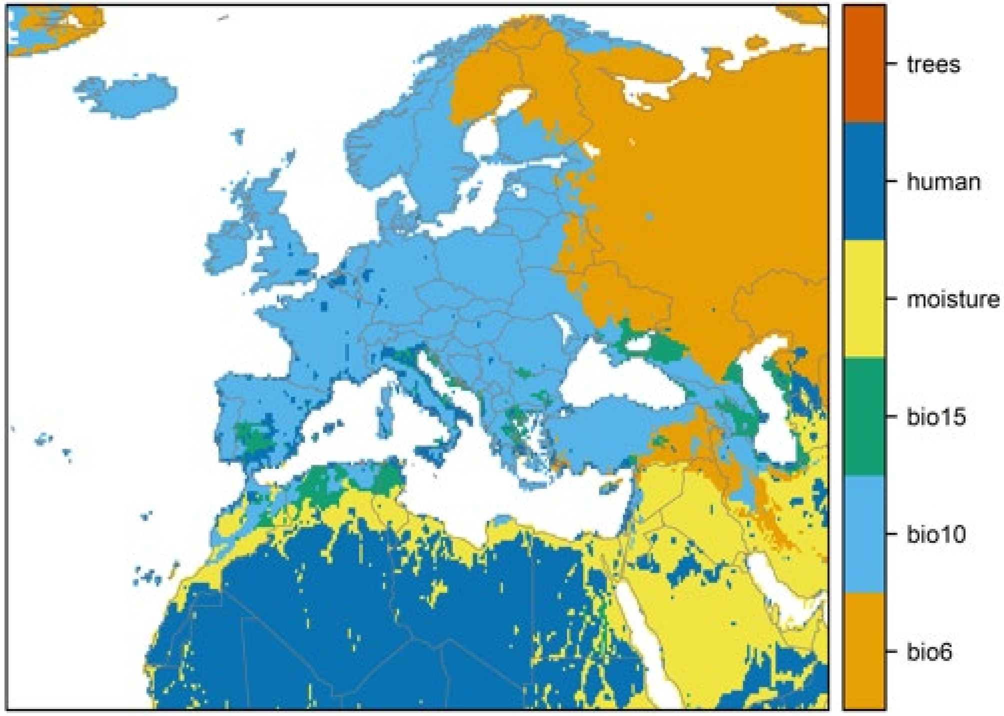


Figure 7. Projected suitability for *Acridotheres tristis* establishment in Europe and the Mediterranean region in the 2070s under climate change scenario RCP4.5, equivalent to Figure 5.

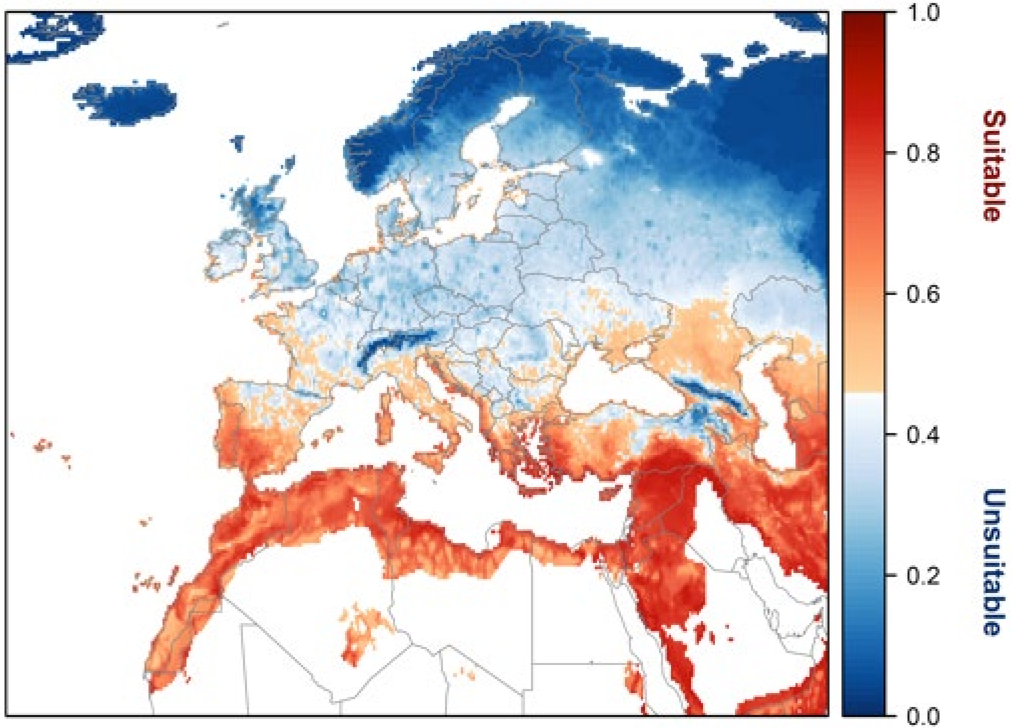


Figure 8. Projected suitability for *Acridotheres tristis* establishment in Europe and the Mediterranean region in the 2070s under climate change scenario RCP8.5, equivalent to Figure 5.

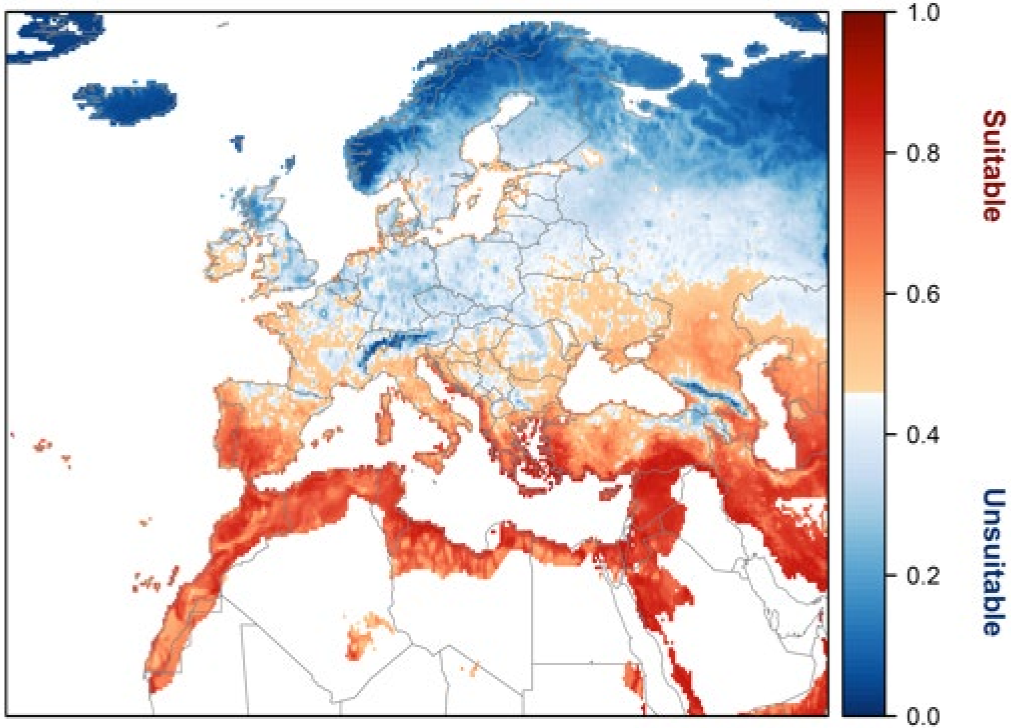
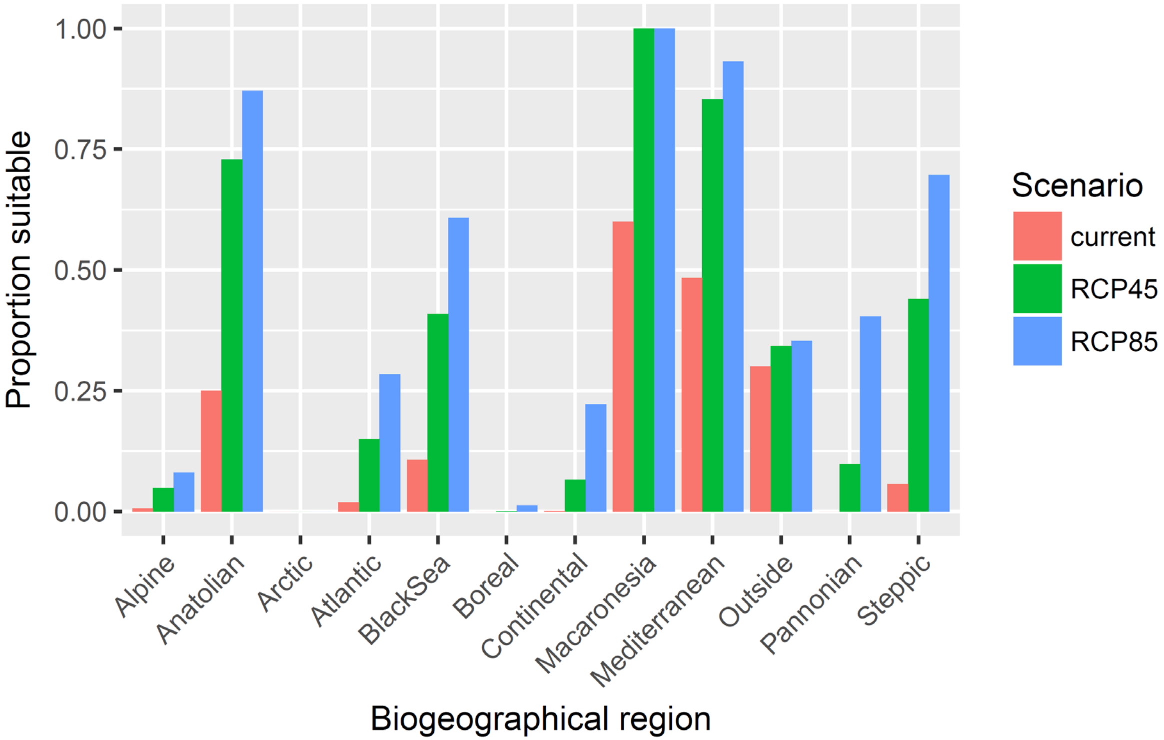


Figure 9. Variation in projected suitability among Biogeographical regions of Europe (Bundesamt fur Naturschutz (BfN), 2003). The bar plots show the proportion of grid cells in each region classified as suitable in the current climate and projected climate for the 2070s under two RCP emissions scenarios. The location of each region is also shown.



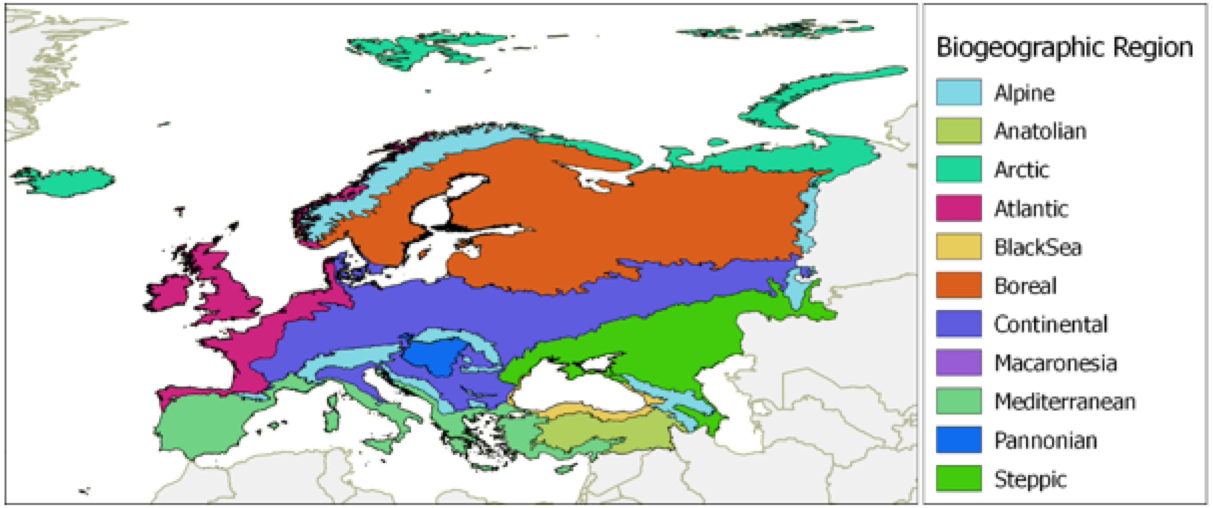
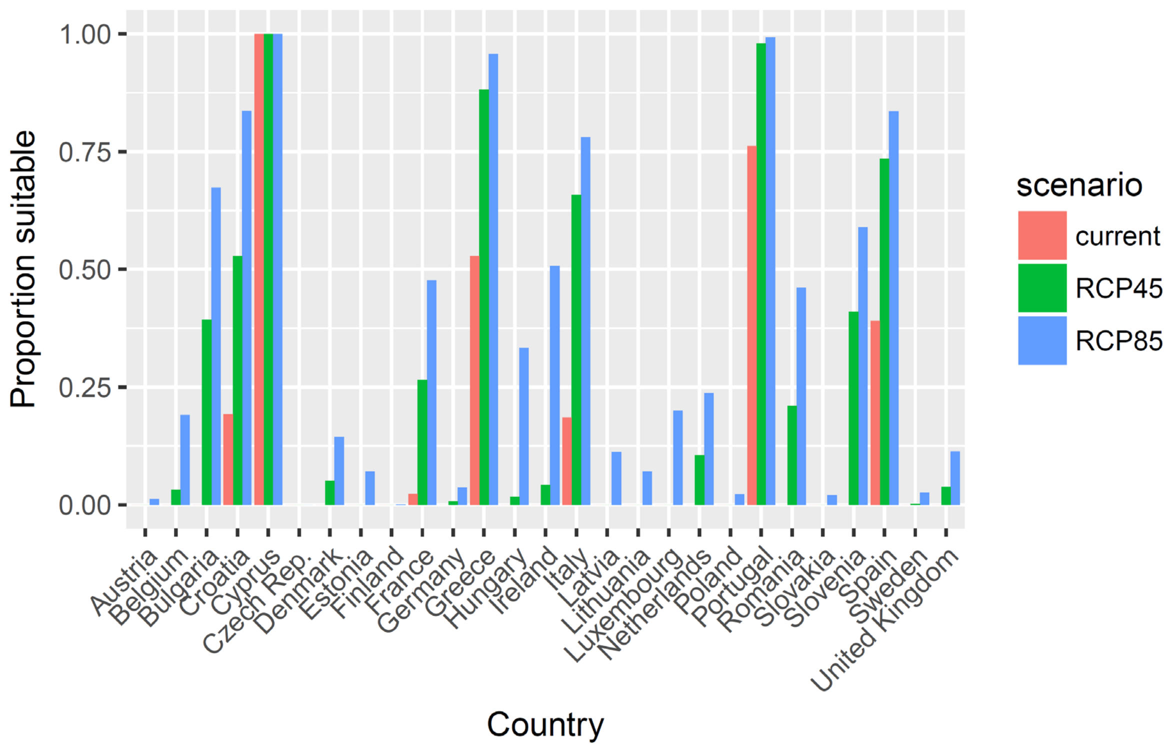

Biogeographic Region
Alpine
Anatolian
Arctic
Atlantic
BlackSea
Boreal
Continental
Macaronesia
Mediterranean
Pannonian
Steppic

Figure 10. Variation in projected suitability among European Union countries. The bar plots show the proportion of grid cells in each country classified as suitable in the current climate and projected climate for the 2070s under two RCP emissions scenarios.



Caveats to the modelling

To remove spatial recording biases, the selection of the background sample was weighted by the density of Aves records on the Global Biodiversity Information Facility (GBIF). While this is preferable to not accounting for recording bias at all, it may not provide the perfect measure of recording bias.

There was substantial variation among modelling algorithms in the partial response plots (Figure 3). In part this will reflect their different treatment of interactions among variables. Since partial plots are made with other variables held at their median, there may be values of a particular variable at which this does not provide a realistic combination of variables to predict from.

Other variables potentially affecting the distribution of the species, such as land cover were not included in the model.

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ANNEX V - Evidence on measures and their implementation cost and cost-effectiveness

Species (common name)	Common Myna
Species (scientific name)	*Acridotheres tristis*
Date Completed	2 Oct 2017
Authors	Peter Robertson, Riccardo Scalera, Wolfgang Rabitsch, Piero Genovesi, Tim Adriaens, Jill Key, Olaf Booy, Niall Moore
Version	4.0

	Description of measures[1]	**Assessment of implementation cost and cost-effectiveness (per measure)**[2]	**Level of confidence in the available information**[3]
Methods to achieve prevention [4]	**Managing pathways**: Mynas have been introduced to new areas through a variety of pathways, including the pet trade, deliberate introductions (Saavedra 2010) and via human assisted transport on ships. The adoption and enforcement of appropriate legislation and codes of best practice to reduce the risks posed by these pathways should reduce the probability of further introductions		
	Effective surveillance and reporting: Mynas are a highly visible species often found in association with human activity. Encouraging rapid reporting of new incursions increases the likely success of rapid response before the species can become established.	Citizen-science species occurrence datasets are increasingly recognized as a valid tool for monitoring the occurrence and spread of invasive species across large spatial and temporal scales (Roy *et al.*, 2015). They are dependent on citizen-scientists who collect and upload data, typically from 'opportunistic sampling' with no underlying scientific survey design (Boakes *et al.*, 2010) which can limit the conclusions that can be drawn from these data (Isaac *et al.*, 2014). Most parts of north-west Europe have an extensive network of volunteer observers although this is less true of southern and especially eastern Europe (Boakes *et al.*, 2010). Nevertheless the focus on native species, which is typical for monitoring activities carried out by bird-watchers may lead to disregard the presence of non-native species, and consequently to a delay in detecting a new presence of this non native species. However, this naturalist community also provides	

		an opportunity for developing an effective surveillance system. Unstructured citizen-science data do not reliably allow to estimate species abundance or population trends (Kamp *et al.*, 2016), yet in an early-warning scenario it is likely sufficient to know where a species is establishing, and these data limitations are thus of a lesser concern.	
	Raising awareness: Raising public awareness of the risks posed by invasive alien species in general and Mynas in particular. The production of targeted publicity and identification material.	Pham and van Son (2009) provide advisory and educational material to support community based control and surveillance of this species	
Methods to achieve eradication [5]	**Trapping**: A variety of designs are available for funnel entry or walk-in traps. Traps must be monitored at least on a daily basis and any caught birds removed, preferably after dark. The traps need to be furnished with shade, water, food and a perch for the humane treatment of trapped birds. Tindall (1996) and Tindemann (2005) describe wire netting cage-traps with walk-in funnel entrances that can also be used to contain a decoy bird. More recently Pham and van Son (2009), Saavedra (2010) and Feare (2017) describe a variety of trap designs and their practical use. A wide range of myna traps based on these designs are commercially available and described on-line (search term 'myna trap'). Good trap sites are placed at sites with low levels of disturbance and open sites at least 3 m from vegetation that can harbour ground predators. Australian studies suggest the most effective baits were dried dogfood or chicken dog food rolls, provided as a pre-feed for 3 days before the trap was set. Dried animal pellets, bread, fried potatoes, tuna, canned meat, rice and fruits have all been reported as useful baits.	Traps, in particular decoy traps, are an effective method to catch Mynas and have been successfully used to support control and eradications including New Zealand, Australia, Pacific Islands, the Seychelles and Azores (Tindall, 1996; Wilson, 1973, Canning 2011). Saavedra (2010) reviewed Myna control on islands, largely based on trapping, including successful eradications from Tenerife (5 months to remove 10 birds), Gran Canaria (10 days to remove 3 birds) and Mallorca (30 days to remove 12-17 birds). Feare et al (2017) eradicated Mynas from St Denis in the Seychelles, removing 1186 birds over 5 years, mainly by decoy trapping. Mynas are intelligent birds and will quickly learn to avoid traps if they are not used carefully. It is best to set and check traps during darkness so the birds do not associate them with people. A proportion of birds may become trap-shy and eradication programmes should also have other methods available to deal with this eventuality. Any control of a vertebrate is likely to attract some opposition, but live capture traps have been widely used in Myna control programmes with the active cooperation of the public (Feare and Cruz 2009, Pham and van Son 2009). The use of decoy animals brings added complications, and potential welfare concerns. Decoys require food, water, perches, space to stretch and shelter when in the trap and care is needed to ensure their welfare. Traps are simple to manufacture and the skills should be available locally	High - Decoy traps are widely recognised as a successful method for capturing Mynas and have been the main method used to support successful eradications

	Captured birds can be humanely dispatched. Designs have also been produced which enclose the trap in a canvas sleeve which could then be flooded with CO^2 to humanely kill captured birds (Tidemann 2005, described in Pierce 2005). **Decoy-traps**: Any form of wire-netting trap that contains one or two decoy Mynas. The decoy birds are usually in a separate chamber and must be provided with shade, food and water (Sharp and Saunders 2004). The decoy birds serve to attract foraging Mynas towards the trap. Decoy traps are particularly effective when catching juvenile birds but are also effective for adults. Decoy birds can be used in most trap types if suitably modified. The traps must be frequently monitored and caught Mynas are best removed at night.	after adequate training. A range of effective designs have been published and are available commercially. The main costs of their use are manpower for setting and checking. Experience of trap placement is required for their effective use and this can take time to develop. The use of decoy birds and traps may be covered by local MS regulations. Local authorities should be asked for authorisation before their use. Traps are likely to also catch other birds and mammals. Regular checking and the release of non-target species can reduce the risks posed. The regular catching of non-target species can reduce the effectiveness of traps for Mynas (Feare et al 2017) Traps are a relatively safe and benign method of capture. If used appropriately they do not pose particular health and safety, environmental, economic or social risks (although they can be mis-used to capture other protected species). The use of decoy traps is likely to be the most effective method to eradicate Mynas, but needs to be used carefully to avoid trap-shyness. Other methods such as shooting, mist-netting and noose-trapping should be used in conjunction with traps to remove trap shy individuals and the initial decoy birds.	
	Mist-nets: Mist nets are fine polyester or nylon nets which are suspended between two upright poles, requiring continual monitoring and expert handling of caught birds (Sharp and Saunders, 2004).	Mist nets need to be used under constant supervision to quickly remove captured birds, reducing their cost-effectiveness compared to other methods. Since Mynas are very wary birds and learn from observation, mist nets are unlikely to be an effective method to routinely catch this species. Wilson (1973) found mist nets to be the least successful method trialled. However, they can be useful to capture the first birds to use as decoys in cage traps. Mist nets are commonly used for the live-capture of birds for ringing. Appropriate equipment and experienced personnel should be locally available. Experience and training is required to safely extract birds from the nets and a number of MS run approval and licensing schemes for their	High – mist nets are widely used for the capture of birds even though their cost-effectiveness is low. They have only played a minor role in Myna control

		use. The use of mist nets may be covered by local MS regulations. Local authorities should be consulted before their use. Mist nets are unselective and are likely to catch birds of a range of species. However, trained personnel should be able to extract and release any non-target species caught. Mist nets are widely used for bird ringing, their use poses few risks to health and safety, the environment, economy or society.	
	Noose-traps: A number of nylon nooses are nailed to the entrance of a nestbox once it has been established that it is occupied by Mynas. Both male and female birds can be captured using this method. (Dhami 2009)	This method is labour intensive and monitoring is required beforehand to identify Myna nests and during use to remove birds once captured. The cost-effectiveness is therefore low. However, this can be a useful method to capture the first birds to use as decoys in cage traps or trap shy birds during an eradication (Millet et al 2004). The acceptability, availability, approvals and risks associated with this method are the same as for mist-nets	High confidence in the assessment of this method. Noose traps are a recognised method that have been used alongside other techniques in reported Myna control programmes. However, their cost-effectiveness is low.
	Roost Netting: Mynas roost in large concentrations, typically in single large trees (Feare and Craig 1998, Yap *et al.* 2002). In Singapore, large numbers of mynas (common mynas and white-vented mynas; *A. javanicus*) and other birds were netted successfully at night using a large "floodlight trap" (described in Pierce 2005). This trap comprised a large funnel of netting (27 m long, 20 m wide, and 40 m high) supported by two cranes each 40 m in height. The mouth of the funnel was placed as close as possible to the edge of the roost with the throat of the funnel connected to a large tent (4 m wide, 3 m high, and 10 m long). Floodlights (5 x 1000 watts) were directed towards the roost. All setting up of	The Singapore example was reported to cost S$20,000 in materials. After a variety of trials in Australia, Tidemann (2010) concluded that it was not practical to trap roosting flocks of mynas and hence he considered this approach to not have potential as a control method. These contrasting views leave the practicality of this approach uncertain although the logistical costs are likely to be high. The public reaction to the Singapore example is not recorded, but a large and logistically complicated operation is likely to attract public attention. The availability of large nets and cranes will be a limiting resource in many areas. While a successful roost capture has the potential to remove a large number of animals in a short period of time, it is unlikely to be effective when only a small numbers of potentially wary animals remain, consequently its use	Medium confidence in the information in the literature – Only successfully used at one site while others suggest the method is ineffective and experience of this method is limited.

	the trap occurred during the day and the roost trees (two Agama trees) were pruned 10 days prior to the first of two operations using the net, which took place 14 days apart. The roost was surrounded by many people at night and the birds were herded towards the light and into the net, with all other street lighting in the area having been extinguished. Captured birds were kept in a series of cages and were subsequently gassed with carbon dioxide, a tank of gas being connected to airtight boxes containing birds.	would need to be combined with the other methods describe here if the objective is eradication. The method is likely to capture a range of commensal species if present, although these can be released unharmed. Its health and safety, environmental and social risks are likely to be minor.	
	Shooting: Shooting by competent marksmen.	Shooting can be an effective method to remove Mynas. It is highly selective and, if used by experienced personnel, provides a humane method of despatch. It is labour intensive but has been used effectively to remove small numbers of birds during the early stages of establishment, and to remove trap shy individuals during eradication (Millet et al 2005, Feare et al 2017). Shooting can be used to take animals during daylight and from the roost at night. Given the wary nature of Mynas, they can quickly learn to avoid shooters although this is less of a problem at night or if silenced weapons are used (Dhami 2009). It may be an effective method to use in association with decoy birds in cages to bring birds within range at sites where it is safe to shoot. The use of different firearms is heavily regulated and the details vary between member states. These are likely to restrict the nature of the weapon, the requirements for the operator and the times and locations where they may be used. Local authorities must be consulted before their use. The use of firearms brings risks to health and safety which need to be managed. Its use in public places is likely to bring opposition and raise particular concerns. The use of lead projectiles has been restricted in some areas due to environmental concerns, although non-toxic alternatives are available.	High -Shooting has been used to remove small populations of Mynas.

	Use of toxins: Spurr and Eason (1999) review the available avicides worldwide. Two compounds have been used control Mynas outside the EU. However, no products are currently approved for use in the EU. The toxicant Starlicide (DRC-1339 or 3-chloro-p-toluidine hydrochloride) (Ramey et al., 1994, ACVM, 2002) and the stupifactant Alphachloralose ((R)-1,2-0-(2,2,2-trichloroethylidene)-α-D-glucofuranose) (Nelson, 1994; Thearle, 1969) are the two main chemical control options tried and tested on mynas outside the EU (Dhami 2009).	Starlicide is not currently approved for use in the EU. It has been used for Myna control in New Zealand (Dhami 2009) and trialed on St Helena and Ascension Island (O'Connor, 1996, Feare 2010). In the past, Alphachloralose has been approved as an avicide and was used in a number of EU states (Ridpath et al., 1961, Spurr and Eason, 1999). However, it is not currently registered for use as an avicide in the EU. It is currently approved for use against rodents (EU Directive 98/8/EC 2008).	High. There is an existing literature on the use and effectiveness of these compounds and examples of their use on Mynas in areas where their use has been approved.
Methods to achieve management [6]	All of the methods described to support eradication can also be used to manage existing Myna populations.	See above	See above
	Reducing Food Supplies: Mynas are effective scavengers and will congregate at available food sources. Restricting access to human and animal foodstuffs and waste at all stages of production, disposal, transport and dumping can reduce the food available to Mynas (Feare and Cruz 2009).		
	Community Based Management: Mynas are often perceived as a pest by the public. A range of community based programmes have been established in Australia to encourage the management and reporting of Mynas (Pham and van Son 2009, Lane Cove Council). As part of public control programmes in Australia, advice has been given to house owners to ensure that rubbish bins and other potential food sources are covered; to avoid feeding birds in gardens; to block potential nest sites, such as holes in roofs or gutters; and to remove any Myna nests found in	Some activities may create unwanted side-effects or conflict. Feeding birds in gardens is a common behaviour of garden owners and blocking potential nest sites, such as holes in roofs or gutters, may have negative effects on other species (e.g. bats).	

	nest boxes or tree hollows on the property (Lane Cove Council). Pham and van Son (2009) provide advisory and educational material to support community based control and surveillance of this species. There has also been programmes based on supplying traps to the general public (Linley, Paton and Weston 2017) although the population level consequences are not reported. Community based programmes are also underway in Tahiti and Tutuila in the Pacific.		

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